

SEQUENCE LISTING

SEQ ID NO: 1 amino acid sequence comprising GAS 40

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE
KTLSQQKAELTELATALTKTTAEINHLKEQQDNEQKALTSAQBIYTNLASSSEETLLAQGAHQRELTA
TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKA
LSSELEKAKADLENQKAKVKKQLTEELAAQKAAALAEKEAELSRKSSAPSTQDSIVGNNTMKAPQGYPLEE
LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRFPVDPNLTPEVQNELAQFAAAMI
NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTHGNTRPSFVYGQPGVSGHYGVGPHDKTIIEDSAGASGLI
RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAFVYLGFTSNV
GSLNEHFVMPESNIAHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA
AQAKVSQLOGKLASTLTKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQ
EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTSSLLNAQEALAAQAKQSS
LEATIATTEHQLTLKTLANEKEYRHLDEDIATVPDLQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL
EASARLAAENTSLVAEALVGQTSSEMASNAIVSKITSSITQPSKTSYSGSSSTSNLISDVDESTQRALK
AGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 2 polynucleotide sequence encoding for GAS 40

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATGCTTTAACCCTCAACAATTGCTTTATT
GAGTGCCAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA
ATACTCAGCAGATAGTTTACCAAACAGAAACAATTCAGAGGCCAAGGCCAATTTGATGCAGTTGAA
AAAACCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAACACTACTGCTGAAAT
CAACCCTTAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATA
CTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAA
ACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTTGTCAGAACAAAAGCTAGCAT
TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGACAAGTCAAACGCTCGAACAAAATATTGCTAAGC
TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA
TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGAC
TGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAGAGGCCAGAAGTTAGTCGCTCTAAATCCTCAG
CTCCGCTACTCAAGTAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAA
CTTAAAATAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATACAAGAGAGCATGAGA
TCAAATATTGCCAAAGCTAGTCCAGGTAATCAATTTAAATCAATACCAAGATATTCCAGCAGATCGTAATC
GCTTTGTTGATCCCGATAATTTGACACCAGAAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT
AATAGTGTAAAGAAGACAATTAGGTCTACCACAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATT
ACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTAT
CAGGGCATTATGGTGTGGGCTCATGATAAACTATTTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT
CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTAACGATGTGCATACCTGTGAATGGTATTAACG
TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA
TTAACTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTGGATTTCAACCAGCAATGTA
GGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGCTAACATTGCTAACCATCAACGCTTTAATAAGAC
CCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACCTGTATCTGATACTATTGCAG
CGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTCATCAAGAAGCTGATATTATGGCA
GCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCT
CCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAG
CACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA
GAAGCCTTAGCAGAGCAAGCCGACGAGTGACAGCACCTGGTGGCTAAAAGCTCATTGCAATATCT
AAGGGACTTTAAATGAACTCAACCCCTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATT
TGGCTAAAACCTCATCTTTGTTAAATGCACAAGAGCTTTAGCAGCCTTACAAGCTAAAACAAGCAGT
CTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTTAAAACCTTAGCTAACGAAAAGGAATA
TCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAAC
CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACGAAACAACATTA
GAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGCTTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAA
GCAGGAGTCGTCATGTTGGCAGCTGTGCGCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 3 amino acid sequence comprising an N terminal leader sequence of GAS 40

MDLEQTKPNQVKQKIALTSTIALLSA

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SEQ ID NO: 4 polynucleotide sequence encoding an N terminal leader sequence of GAS 40
 ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT
 GAGTGCC

SEQ ID NO: 5 amino acid sequence comprising a fragment of GAS 40 with N terminal leader
 sequence removed
 SVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVEKTLSSQKAELELATALTKTTAEINH
 LKEQQDNEQKAL TSAQEIYTNLASSEETLLAQAQAEHQREL TATETELHNAQADQHSKETALSEQKASI SA
 ETTRAQDLVEQVKTSEQNIAKLNAMISNPDAITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEE
 LAAQKAALAEKEAELSRKSSAPSTQDSIVGNNTMKAPQGYPLEELKKLEASGYIGSASYNYYKEHADQI
 IAKASPGNQLNQYQDIPADRNRVFPDNLTEPVQNELAQFAAHMINSVRRQLGLPVTVTAGSQEFARLLS
 TSYKKTGHNTRPSFVYQPGVSGHYGVGPHDKTIIEDSAGASGLIRNDDNMYENIGAFNDVHTVNGIKRGI
 YDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPAPVYLGFTSNVGSLSNEHFVMPESNIANHQRFNKPI
 KAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMAAQAKVSQLQGKLASTLTKQSDSLNLQV
 RQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRD
 FKLNPRLQVIRERIDNTKQDLAKTSSLLNAQEAALQAKQSSLEATIATTEHQTLTKLANEKEYRH
 LDEDIATV PDLQVAPPLTGKPLSYSKIDTTPLVQEMVKETKQLEASARLAAENTSLVAEALVGQTSSEM
 VASNAIVSKITSSITQPSKTSYSGSGSSTSNLISDVDESTQRALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 6 polynucleotide sequence encoding a fragment of GAS 40 with N terminal leader
 sequence removed
 AGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGACCTCAGGAGAAACGAAGGCGAGTAATACTCA
 CGACGATAGTTTACAAAACAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAACTC
 TCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAAC TACTGCTGAAATCAACCAC
 TAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGC
 AAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGC
 TTCATAATGCTCAAGCAGATCAACATTTAAAAGAGACTGCATTTGTCAGAACAAAAGCTAGCATTTTCAGCA
 GAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAAACAAAATATTGCTAAGCTCAATGC
 TATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAAGCT
 CAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGACTGAAGAG
 TTGGCAGCTCAGAAAAGCTGCTTAGCAGAAAAAGAGGCAGAACTTAGTCTGCTTTAAATCCTCAGCTCCGTC
 TACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAACTTAAAA
 AATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAAAT
 ATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCAGCAGATCGTAATCGCTTTGT
 TGATCCCATAATTTGACACCAGAAGTGCAAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATAGTG
 TAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTTAGT
 ACCAGCTATAAGAAAAC TATGGTAATACAAGACCATCATTTGTC TACGGACAGCCAGGGGTATCAGGGCA
 TTATGGTGTGGGCCTCATGATAAACTATTTATGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAAATG
 ATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATAC TGTGAATGGTATTTAAACGTGGTATT
 TATGACAGTATCAAGTATATGCTCTTTACAGATCAATTTACACGGAATACATACGGCCATGCTATTAACCT
 TTTACGTGTAGATAAACATAACCCATAATGCGCCTGTTTACCTGGATTTTCAACCAGCAATGTAGGATCTT
 TGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCTATA
 AAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCAC TGTATCTGATACTATTGCAGCGATCAA
 AGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCTGATATTATGGCAGCCCAAG
 CTAAAGTAAGTCAACTTCAAGGTAATTTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAAGTG
 AGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAGCACAACT
 CGAAGTACTCGTCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCAC TGCACCAGACAGAAAGCCT
 TAGCAGAGCAAGCCGACCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGTGCAATATCTAAGGGAC
 TTTAAATTTGAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGCTAA
 AACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAAGCAGTCTAGAAG
 CTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGCCAC
 TTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTTTACGGGCGTAAAACCGCTATC
 ATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAAACGAAAACAATATTAGAAGCTT
 CAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATGGTA
 GCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGGCTC

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AGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAAAGAGCTCTTAAAGCAGGAG TCGTCATGTTGGCAGCTGTTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAAGTGA

SEQ ID NO: 7 amino acid sequence comprising a C terminal transmembrane region of GAS 40 ALKAGVVMLAAVGLTGFRFRKESK

SEQ ID NO: 8 polynucleotide sequence encoding a C terminal transmembrane region of GAS 40 GCTCTTAAAGCAGGAGTCGTCATGTTGGCAGCTGTTCGGCCTCACAGGATTTAGGTTCCGTAAGGAATCTAA GTGA

SEQ ID NO: 9 amino acid sequence comprising a fragment of GAS 40 with a C terminal transmembrane sequence removed

MDLEQTKPNQVKQKIALTSTIALLSASVGVSHQVKADDRASGETKASNTHDDSLPKPETIQEAKATIDAVE KTLSQQAELTELATALTKTTAEINHLKEQODNEQKALTSAQEIYTNTLASSEETLLAQGAEHQREL TATE TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMI SNPDAITKAAQTANDNTKA LSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAEL SRLKSSAPSTQDSIVGNNTMKAPQGY PLEE LKKLEASGYIGSASYNYYKEHADQIIAKASPGNQLNQYQDIPADRNRVDPDNLTPEVQNELAQFAAHMI NSVRRQLGLPPVTVTAGSQEFARLLSTSYKKTGHGNTSPFVYQPGVSGHYGVGPHDKTIIEDSAGASGLI RNDNMYENIGAFNDVHTVNGIKRGIYDSIKYMLFTDHLHGNTYGHAINFLRVDKHNPNAVLYLGFSTSNV GSLNEHFVMPFESNIANHQRFNKTPIKAVGSTKDYAQRVGTVSDTIAAIKGVSSLENRLSAIHQEADIMA AQAKVSQLQGLASTLQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSLAKLASLKAALHQE EALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTSSLLNAQEALALQAKQSS LEATIATTEHQLTLLKTLANEKEYRHLDEDIATVDPDQVAPPLTGVKPLSYSKIDTTPLVQEMVKETKQLL EASARLAAENTSLVAEALVGQTSSEMVASNAIVSKITSSITQPSKTSYSGSSTTNSLISDVDESTQR

SEQ ID NO: 10 polynucleotide sequence encoding a fragment of GAS 40 with a C terminal transmembrane sequence removed

ATGGACTTAGAACAAACGAAGCCAAACCAAGTTAAGCAGAAAATTGCTTTAACCTCAACAATTGCTTTATT GAGTGCCAGTGTAGGCGTATCTCACCAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTA ATACTCAGCAGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATGATGCAGTTGAA AAAACTCTCAGTCAACAAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGCACAAAACTACTGCTGAAAT CAACCCTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAAGAAATTTACTACTAATA CTCTTGCAAGTAGTGAGGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTAAACAGCTACTGAA ACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTGTCAGAACAAGAAAGCTAGCAT TTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAACAAAATATGCTAAGC TCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCA TTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGAC TGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTTTAAATCCTCAG CTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAA CTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAAAGAGCATGCAGA TCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATCCAGCAGATCGTAATC GCTTTGTTGATCCCGATAATTTGACACCAGAAGTGAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATT AATAGTGAAGAAGACAATTAGGCTTACCACCAGTTACTGTTACAGCAGGATCACAAAGAAATTTGCAAGATT ACTTAGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTGTCTACGGACAGCCAGGGGTAT CAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATT CGAAATGATGATAACATGTACGAGAATATCGGTGCTTTAACGATGTGCATACTGTGAATGGTATTAAACG TGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTA TTAACCTTTTACGTGTAGATAAACATAACCCATAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTA GATCTTTGAATGAACACTTTGTAAATGTTTCCAGAGCTAAACATTTGCTAACCATCAACGCTTTAATAAGAC CCCTATAAAAAGCCGTTGGAAAGTACAAAAGATTATGCCCAAAGAGTAGGCAGTGTATCTGATACTATTGCAG CGATCAAAGGAAAAAGTAAGCTCATTAGAAAATCGTTTGTGGCTATTTCATCAAGAAGCTGATATPATGGCA GCCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAAGCAGTCAGACAGCTTAAATCT CCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAG CACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACA GAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACTGGTGGCTAAAAAAGCTCATTGCAATATCT AAGGGACTTTAAATTTGAATCCTAACCGCCTCAAGTGATACGTGAGCGCATTTGATAACTAAGCAAGATT

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TGGCTAAAACCTACCTCATCTTTGTTAAATGCACAGAAGCTTTAGCAGCCTTACAAGCTAAAACAAAGCAGT
 CTAGAAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATA
 TCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTTTACGGGCGTAAAAC
 CGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAAGAAATGGTTAAAGAAACGAAACAACTATTA
 GAAGCTTACAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGA
 AATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATCTT
 ATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAAGTACTCAAAGA

SEQ ID NO: 11 amino acid sequence comprising a transmembrane region of GAS 40 as shown in Figures 1 and 2. ALKAGVVMLAAVGLTG

SEQ ID NO: 12 amino acid sequence comprising a first coiled-coil region of GAS 40
 ETIQEAKATIDAVEKTLSSQKAELELATALTKTTAEINHLKEQQDNEQKAL TSAQEIYTNLTLASSEETLL
 AQGAHQREL TATE TELHNAQADQHSKETALSEQKASISAETTRAQDLVEQVKTSEQNIAKLNAMI SNPDA
 ITKAAQTANDNTKALSSELEKAKADLENQKAKVKKQLTEELAAQKAALAEKEAEL SRLKSSA

SEQ ID NO: 13 amino acid sequence comprising a second coiled-coil region of GAS 40
 RLSAIHQEADIMAAQAKVSQLQGKLASTLKQSDSLNLQVRQLNDTKGSLRTELLAAKAKQAQLEATRDQSL
 AKLASLKAALHQTEALAEQAAARVTALVAKKAHLQYLRDFKLNPNRLQVIRERIDNTKQDLAKTTSSLLNA
 QEALALQAKQSSLEATIATTEHQLTLKTLANEKE

SEQ ID NO: 14 amino acid sequence comprising a leucine zipper motif within the second coiled-coil region of GAS 40.
 QVIRERIDNTKQDLAKTTSSLLNAQEALAL

SEQ ID NO: 15 amino acid sequence comprising SpA from *Streptococcus gordonii* Genbank reference GI 25990270

MNKRKEVFGFRKSKVAKTLGAVLGAALIAIADQOVLADEVTETNSTANVAVTTTGNPATNLPEAQGEATE
 AASQSQAQAGSKEGALPVEVSADDLNQAVTDAKAAGVNVVQDQTSKGTATTAAENAQKQAEIKSDYAKQA
 EEIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAKLAQYQKDL
 AAVQKANEDSQLDYQNKLSAYQAEELARVQKANAEAEKAVKENTAKNAALQAENEAIKQRNETAKANY
 DAAMQYEAADLAAIKKAKEDNDADYQAKLAAAYQAEELARVQKANADAKAAEYKAVEENTAKNTAIQAENEAI
 KQRNAAKATYEAALKQYEADLAAAKANEDSDADYQAKLAAAYQTELARVQKANADAKAAEYKAVEDNKAK
 NAALQAENEAIKQRNAAAKTDYEAKLAKYEADLAKYKKELAEYPAKLKAYEDEQAQIKALVELEKKNQD
 GYLSKPSAQSLVYDSEPNAQLSLTTNGKMLKASAVDEAFSHDTAQYSKKILQPDNLNVSYLQQADDVTSSM
 ELYGNFGDKAGWTTTVGNNTVEVKFASVLLERQSVTATYTNLEKSYNGKKISKAVFKYSLDSDSKFKNVD
 KAWLGVLPDPTLGVFASAYTGQEEKDTSIFIKNEFTFYDENDQPINFDNALLSVA SLNRENNSIEMAKDYS
 GTFVKISGSSVGEKDGKIYATETLNFKQGGSRWMTMYKNSQPGSGWSSDAPNSWYGAGAISMSGPTNHV
 TVGAI SATQVVP SDPVM VATGKRPN I WYSLNGKIRAVNVPKITKEKPTPPVAPTEPQAPTYEVEKPLEPA
 PVAPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVVPTYENEPTPPVKTPDQPEPSKPEEPTYET
 EKPLEPAPVAPTYENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPVAPTPKQLPTPPVVPTVHFHYSSLLAQ
 PQINKEIKNEDGVDIDRTLVAKQSIKVFELKTEALTAGRPKTSFVLVDPLPTGYKFDL DATKAASTGFDT
 TYDEASHVTVFKATDETLATYNADLTKPVETLHPTVVGRVLDGATYINNFTLTVNDAYGIKSNVVRVTTTP
 GKPNDPDPNPNNYIKPTKVNKNKEGLNIDGKEVLGSTNYEYELTWDLQYKGDKSSKEAIQNGFYVDDYP
 EEALDVRPDLVKVADEKGNQVSGVSVQYDSLEAAPKKVQDLLKKNITVKGAFQLF SADNPEEFYKQYVS
 TGTSLVITDPMTVKSEFGKTGGKYENKAYQIDFGNGYATEVVVNNV PKITPKKDVTVSLDPTSENLDGQTV
 QLYQTFNYRLIGGFI PQNHSELEEDYSFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGD TLTSQTTA
 ETDAANGIVTVRSKEDSLQKISLSDSPFQAETYLQMRRIAIGTFENTYVNTVNKVAYASNTVVRTTPIPRTP
 DKPTPIPTPKPKDPKPKPETPKPKVSPKVEDPSAPIPVSVGKELTTLPKTGTNDSSYMPYLGALAVGVL
 GLGQLKRKEDES

SEQ ID NO: 16 amino acid sequence comprising Streptococcal surface protein B precursor from *Streptococcus gordonii* Genbank reference GI 25055226 AAC44102.3

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MQKREVFGRKSKVAKTLCGAVLGAALIAIADQQVLADEVTETNSTANVAVTTTGNPATNLPEAQGREATEA
 ASQSQAQAGSKDGALPVEVSADDLKNKAVTDAKAAGVNVVQDQTSKGTATTAENAQKQAEIKSDYAKQAE
 EIKKTTEAYKKEVEAHQAETDKINAENKAAEDKYQEDLKAHQAEVEKINTANATAKAEYEAQLAQYQKDLA
 AVQKANEDSQLDYQNKLSAYQAEELARVQKANAEAKEAYEKAVKENTAKNAALQAENEAIKQRNETAKANYD
 AAMKQYEAADLAAIKKAKEDNDADYQAKLAAYQAEELARVQKANADAKAAVEKAVEENTAKNTAIAENEAIK
 QRNETAKATYEAAVKQYEAADLAAVKQANATNEADYQAKLAAYQTEELARVQKANADAKATYKAVEDNKAKN
 AALQAENEEIKQRNAAAKTDYEAKLAKYEADLAKYKDFAAAYTAALAEAESKKKQDGYLSEPRSQSLNFKS
 EPNAIRTIDSSVHQYQQEELDVLKSWGISPTNPDRKKSTAYSYFNAINSNNTYAKLVLEKDKPVDVTTYTG
 LKNSSFNKGKISKVVYTYTLKETGFDDGKMTMFASSDPTVTAWYNDYFTSTNINVKVKFYDEEGQLMNL
 GGLVNFSSLNRGNGSGAIDKDAIESVRNFRNGRYIPISSGSIKIHENNSAYADSSNAEKSRGARWDTSEWDT
 TSSPNINWYGAIVGEITQSEISFNMASSKSGNIWFAPNSNINAIGVPTKPVAPTAPTQPMYETEKPLEPAPV
 VPTYENEPTPPVKTPDQPEPSKPEEPTYETEKPLEPAPVAPTYPENEPTPPVKIPDQPEPSKPEEPTYETEK
 PLEPAPVAPTYPENEPTPPVKTPDQPEPSKPEEPTYDPLPTPPLAPTQKQKLPVPTVHFHYSSLLAQFPQ
 INKEIKNEDGVDIDRTLVAKQSIGKFEKTEALTAGRPKTSFVLVDPLPTGYKFDLDATKAASTGFDTTY
 DEASHTVTFKATDETATYNADLTKPVETLHPTVVGRVLDGATYTNFTLTVNDAYGIKSNVVRVTTPGK
 PNDPDNPNNNYIKPTKVNKNKEGLNIDGKEVLGASTNYEELTWDLQYKGDSSKEAIQNGFYVDDYPEE
 ALDVRPDLVKVADEKGNQVSGVSVQQYDSLEAAPKKVQDLLKANIIVKGAQQLFSADNPEEFYKQYVSTG
 TSLVITDPMVTSEFGKTEGKYENKAYQIDFGNGYATEVVVNVKPIPKKDVTVSLDPTSENLDGQTAVQL
 YQTFNYRILGGFI PQNHGSELEDYSFVDDYDQAGDQYTGNYKTFSSLNLTMKDGSVIKAGTDLTSTQTAET
 DATNGIVTVRFKEDFLQKISLDSFQAETYLQMRRIAIGTFENTYVNTVNKVAYASNTVTRTTTPIPRTPDK
 PTPIPTPKPKDPDKPETPKEPKVPSPKVEDPSAPIPVSVGKELTTLPKTGTNDATYMPYLGALALVGLGL
 GLAKRKED

SEQ ID NO: 17 amino acid sequence comprising PspA from *Streptococcus pneumoniae*
 Genbank reference GI 282335

MNKKMILTSLASVAAILGAGFVASQPTVVRAEESPVASQSKAEKDYDAKKDAKNAKKAVEDAQKALDDAK
 AAQKKYDEDQKKTEEKAALKAASEEMDKAVAAVQQAYLAYQQATDKAAKDAADKMIIDEAKKREEEAKTKF
 NTVRAMVPEPEQLAETKCKKSEAKQKAPELTKKLEAKAKLEEAKEKATEAKQKVDAAEVAQAKIAELE
 NQVHRLEQELKEIDSESEDYAKEGFRAPLQSKLDAKKAKLSKLEELSDKIDELDAEIAKLEDQLKAAEEN
 NNVEDYFKEGLEKTIAAKKALEKTEADLKKAVNEPEKPAPEPAPAEQPKPAPAPQAPAPKPEK
 PAEQPKPEKTDQQAEDYARRSEEEYNRLTQQQPPKAEPAPAPKTKGWKQENGMWYFYNTDGSMTGWLQ
 NNGSWYYLNSNGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNAN
 GAMATGWAKVNGSWYYLNANGAMATGWLQYNGSWYYLNANGAMATGWAKVNGSWYYLNANGAMATGWVKD
 DTWYYLEASGAMKASQWPKVSDKWYYVNGLGALAVNTTVDGYKVNANGEWV

SEQ ID NO: 18 amino acid sequence comprising a portion of Se89.9 of *Streptococcus equi*
 Genbank reference GI 2330384

ESDIVDATRFSTTEIPKSGQVIDRSASIQALTNDIASIKGKIASLESRLADPSSEAEVTAQAQKISQLQH
 QLEAAQAKSHKLDQQVEQLANTKDSLRTQLLAAKEEQAQLKANLDKALALLASSKATLHKLEAAMEEAKA
 RVAGLASQKAQLEDLLAFEKNPNRIELAQEKVAAKKALADTEDKLLAAQASLSDLQAQRARLQLSIATI

SEQ ID NO: 19 polynucleotide sequence comprising GST-40-HIS

CTGGTTCGCGTGATCCCATATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGG
 AGAAACGAAGGCGAGTAATACCTCAGCAGATAGTTTACCAAAACCAGAAACAATCAAGAGGCAAAGGCAA
 CTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAAGTACGACAGCTTGTCTACCGCTCTGCACA
 AAAACTACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACTCTGCACA
 AGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAGAG
 AGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCA
 GAACAAAAAGCTAGCATTTCAGCAGAAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGCTCTGA
 ACAAAATATGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTA
 ATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAAGCTGACTTAGAAAATCAAACGCTAAA
 GTTAAAAAGCAATGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAG
 TCGTCTTAAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGCAAG
 GCTATCCTCTTGAAGAATTAAAAAATTAGAAGCTAGTGGTTATATGGATCAGCTAGTTACAATAATTAT
 TACAAAGAGCATGCAGATCAAAATATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATAT
 TCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAATGAGCTAGCGCAGT

SEQUENCE LISTING

TTGCAGCTCACATGATTAATAGTGTGAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCA
 CAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTGTGCTA
 CGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAGACTCTGCCG
 GAGCGTCAGGGCTCATTGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACT
 GTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTACACGGAAA
 TACATACGGCCATGCTATTAACCTTTTACGTGTAGATAAAACATAACCCTAATGCGCCTGTTTACCTGGAT
 TTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTCCAGAGTCTAACATTGCTAACCAT
 CAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGT
 ATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTTCATCAAG
 AAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAG
 TCAGACAGCTTAAATCTCCAAGTGAGACAATTAAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGC
 AGCTAAAGCAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAG
 CCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAAGCCGACGCCAGAGTGACAGCACTGGTGGCTAAAAAA
 GCTCATTGCAATATCTAAGGGACTTTAAATGAAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGA
 TAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCCTTAC
 AAGCTAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTA
 GCTAACGAAAAGGAATATCGCCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACC
 TCTTACGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAAATGGTTAAAG
 AAACGAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTT
 GTTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGCTAAAATCACATCTTCGATTACTAGCC
 CTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGACCAATCTCATTCTGATGTTGAAAGTA
 CTCAAAGAGCTCTTAAAGCAGGAGTCGTATGTTGGCAGCTGTGCGCCTCACAGGATTTAGGTTCCGTAAG
 GAATCTAAGGCGGCCCACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 20 amino acid sequence comprising GST-40-HIS

L V P R G S H Met S V G V S H Q V K A D D R A S G E T K A S N T H D D S
 L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T
 K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E
 T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E
 Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N
 P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V
 K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I
 V G N N T Met K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
 K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
 T P E V Q N E L A Q F A A H Met I N S V R R Q L G L P P V T V T A G S Q
 E F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P
 H D K T I I E D S A G A S G L I R N D D N Met Y E N I G A F N D V H T V
 N G I K R G I Y D S I K Y Met L F T D H L H G N T Y G H A I N Q L R V D
 K H N P N A P V Y L G F S T S N V G S L N E H F V Met F P E S N I A N H
 Q R F N K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S
 S L E N R L S A I H Q E A D I Met A A Q A K V S Q L Q G K L A S T L K Q
 S D S L N L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R
 D Q S L A K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A
 H L Q Y L R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L
 L N A Q E A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N
 E K E Y R H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T
 T P L V Q E Met V K E T K Q L L E A S A R L A A E N T S L V A E A L V G
 Q T S E Met V A S N A I V S K I T S S I T Q P S S K T S Y G S G S T T
 S N L I S D V D E S T Q R A L K A G V V Met L A A V G L T G F R F R K E
 S K A A A L E H H H H H H

SEQ ID NO: 21 polynucleotide sequence comprising 40a-HIS

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCT

SEQUENCE LISTING

TCGAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG.
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGCATTTC
GCAGAAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCACAAGGCTATCCTCTTGAAGAACTTA
AAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATFAAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAAGAAGACAATTAGGTCTACCACCAGTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACCTATGGTAATACAAGACCATCAATTTGCTACGGACAGCCAGGGTATCAGG
GCATTTAGTGGTGGGCTCATGATAAAAATAATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACGTGAATGGTATTAACCGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTTACGTGTAGATAAACATAACCCTAATGCGCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAAGTACAAAAGATTATGCCCAAAGAGTAGGCACGTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAAGTAAGTCAACTCAAGGTAAATTAGCAAGCACACTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAAGTACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGACCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
GACTTTAAATTTGAATCCTAACCGCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCGTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAGATGGTTAAAGAAAACGAAACAACATATTAGAAG
CTTCAGACAAGATTAGCTGTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGCTAAAATCACATCTTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAGCGCGCCGCACTCG
AGCACCACCACCACCACCACC

SEQ ID NO: 22 amino acid sequence comprising 40a-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S F G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S
T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q
S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T Q L
L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I

SEQUENCE LISTING

T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
L E H H H H H H H

SEQ ID NO: 23 polynucleotide sequence comprising 40a-RR-HIS

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAAACCAGAAAACAATTCAGAGGGCAAAGGCAACTATTGATGCAGTTGAAAAAA
CTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGTACCGCTCTGACAAAACACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAATTTACTACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAGAGAGTTAACAGCTACTGAAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAGCTAGCATTTCA
GCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAA
GCTCAGAATTGGAGAAGGCTAAAAGCTGACTTAGAAAATCAAAGCTTAAAGTTAAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAGAGGCAGAAGTTAGTCGTCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTTGTGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAAGTTA
AAAAATTAGAAGCTAGTGGTTATATGGATCAGCTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTACGtGtCAATTAGGTTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGATTAAGT
AGTACCAGTATAAGAAAACCTCATGGTAATAACAAGCACATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTCGAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAAGCCGTTGGAAAGTACAAAAGATTATGCCCAAAGAGTAGGCACCTGTATCTGATACTATTGACAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAAGCACACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGACAGCCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
GACTTTAAATGAATCCTAACCGCCTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
TAAACTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAGATGGTTAAAGAAACGAAACAACCTATTAGAAG
CTCAGCAAGATTAGCTGCTGAAAATACAAGTCTGTAGCAGAAGCGCTTGTGTCGCAAAACCTCTGAAAATG
GTAGCAAGTAATGCCAATGTTGTCTTAAATCACATCTTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAGtGtGCGGCCGCACTCG
AGCACCACCACCACCACCACC

SEQ ID NO: 24 amino acid sequence comprising 40a-RR-HIS

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A Met I S N P D A I T K A A
Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L
A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A
P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A
K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A
Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y
K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A
G A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I
K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F
S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S

SEQUENCE LISTING

T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A
 D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T
 K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L
 H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R
 L Q V I R E R I D N T K Q D L A K T T S S L L N A Q B A L A A L Q A K Q
 S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V
 P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L
 L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I
 T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A A
 L E H H H H H H H

SEQ ID NO: 25 polynucleotide sequence comprising 40a-RR (nat)

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
 TCACGACGATAGTTTACCAAAACCAGAAAACAATTCAAGAGGCCAAAGGCAACTATTGATGCAGTTGAAAAAA
 CTCTCAGTCAACAAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAAACTACTGCTGAAATCAAC
 CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACTACTAATACTCT
 TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
 AGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTCA
 GCAGAAACTACTCGAGCTCAAGATTTAGTGGAAACAGTCAAACCGCTGAACAAAATATTGCTAAGCTCAA
 TGCTATGATTAGCAATCCTGATGCTACTAAAGCAGCTCAAACGGCTAAATGATAATACAAAAGCATTAA
 GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAGCAATTGACTGAA
 GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTCTTAAATCCTCAGCTCC
 GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAAGTTA
 AAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAGAGCATGCAGATCAA
 ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAATCGCTT
 TGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
 GTGTAGGtGtCAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAGAATTTGCAAGATTACTT
 AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
 GCATTATGGTGTGGGCCTCATGATAAAAATTTAATTGAAGACTCTGCCGGAGCGTCAGGGCTCATTTGAA
 ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT
 ATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGCTATTA
 CTTTTTACGTGTAGATAAACATAACCCTAATGCGCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
 CTTTGAATGAACACTTTGTAATGTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAGACCCCT
 ATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCCTGTATCTGATACTATTGCAGCGAT
 CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
 AAGCTAAAGTAAGTCAACTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
 GTGAGCAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAAACAGCACA
 ACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
 CCTTAGCAGAGCAAGCCGACAGCAGAGTGACAGCACTGGTGGCTAAAAAGCTCATTGCAATATCTAAGG
 GACTTTAAATTTGAATCCTAACCGCTTCAAGTGATACGTGAGCGCATTGATAATACTAAGCAAGATTTGGC
 TAAAACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
 AAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAATATCGC
 CACTTAGACGAAGATATAGCTACTGTGCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAAACCGCT
 ATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAGTGGTTAAAGAAACGAAACAACCTATTAGAAG
 CTTTAGCAAGATTAGCTGCTGAAAATACAAGCTTTGAGCAGAAGCGCTTGTGGCCAAACCTCTGAAATG
 GTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
 CTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAAcGt

SEQ ID NO: 26 amino acid sequence comprising 40a-RR (nat)

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
 E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
 L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
 H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
 T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
 T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E L A
 A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P

SEQUENCE LISTING

Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
 A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
 F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
 K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
 A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
 Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S
 T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
 K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
 I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
 G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
 Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
 Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
 S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
 D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L
 E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
 S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R

SEQ ID NO: 27 polynucleotide sequence comprising HIS-40a NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGTGAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
 AGCCTCAGGAGAAACGAAGGCGAGTAATACTCAGCAGTAGTGTACCAAAACCAGAAACAATTCAAGAGG
 CAAAGGCAACTATTGATGCAGTTGAAAAAATCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACC
 GCTCTGACAAAACTACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAAC
 CTCTGCACAAGAAATTTACTACTAATACTCTTGAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
 ACAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACT
 GCATTGTGAGAACAAAAGCTAGCATTTACAGCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAA
 AACGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAAGCAGCTC
 AAACGGTAAATGATAATACAAAAGCATTAAAGCTCAGAATGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
 AAAGCTAAAGTTAAAAAGCAATTGACTGAAGAGTGGCAGCTCAGAAAGCTGCTTAGCAGAAAAGAGGC
 AGAAGTTAGTCGTCTTAAATCCTCAGCTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAG
 CACCGCAAGGCTATCCTCTTGAAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
 AATAATTATTACAAAGAGCATGCAGATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAATCAATA
 CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGC
 TAGCGCAGTTTGCAGCTCATATGATTAATAGTGTAAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACA
 GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAATCATGGTAATACAAGACCATC
 ATTTGTCTACGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCCCTCATGATAAACTATTATTGAAG
 ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGAT
 GTGCATCTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATT
 ACACGGAAATACATACGGCCATGCTATTAACTTTTTACGTGTAGATAAACATAACCCCTAATGCGCCTGTTT
 ACCTTGGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATT
 GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATGATGCCCAAAGAGT
 AGGCATGTATCTGATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTA
 TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACA
 CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAAGTTCTTTGAGAACAGA
 ATTACTAGCAGCTAAAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
 CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGGAGTGACAGCACCTGGTG
 GCTAAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATGAAATCCTAACCCCTTCAAGTGATACGTGA
 GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
 CAGCCTTACAAGCTAAAACAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
 AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCTGATTGCAAGT
 AGCTCCACCTCTTACGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAA
 TGGTTAAAGAAAACGAAAACAATATTAGAAGCTTACAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
 GAAGCGCTTGTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
 TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
 ATGAAAGTACTCAAGGt

SEQ ID NO: 28 amino acid sequence comprising HIS-40a NH

SEQUENCE LISTING

M G S H H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A B L T B L A T A
L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
T P E V Q N E L S Y Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
F A R L L S T S Y K K T H G N T R P S F V Y G Q P G V S G H Y G V G P H
D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L N A Q E
A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
D E S T Q R

SEQ ID NO: 29 polynucleotide sequence comprising HIS-40a CH

ATGGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAG
TAATACTCAGCAGATAGTTTACCAAACAGAAACAATTCAGAGGCAAAGGCAACTATTGATGCAGTTG
AAAAAAGCTCTCAGTCAACAAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACGAAAAGCTACTGCTGAA
ATCAACCAATTAAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAA
TACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTG
AAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGC
ATTTACAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACGCTCTGAACAAAATATTGCTAA
GCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAG
CATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAAAGCTAAAGTTAAAAAGCAATTG
ACTGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGCTTTAAATCCTC
AGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCCGCAAGGCTATCCTCTTGAAG
AACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAAGAGCATGCA
GATCAAAATTATTGCCAAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAA
TCGCTTTGTTGATCCCGATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGA
TTAATAGTGTAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGAATTTGCAAGA
TTACTTAGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATCTGTCTACGGACAGCCAGGGGT
ATCAGGGCATTATGGTGTGGGCTCATGATAAACTATTATTGAAGACTCTGCCGGAGCGTCAGGGCTCA
TTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAA
CGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACATACGGCCATGC
TATTAACCTTTTACGTGTAGATAAACATAACCCATAACGCTTAACTGCTGTTTACCTTGGATTTTCAACCAGCAATG
TAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACGCTTTAATAAG
ACCCCTATAAAAAGCCGTTGGAAAGTACAAAAGATTATGCCCAAAGAGTAGGCACTGTATCTGATACTATTGC
AGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGGCTATTTCATCAAGAAGCTGATATTATGG
CAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTTAGCAAGCACACTTAAGCAGTCAGACAGCTTAAAT
CTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTAAAGCAAACA
AGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAAGCCGCACTGCACCAGA
CAGAAGCTTTAGCAGAGCAAGCCGACAGCAGTGCAGCAGCTGGTGGCTAAAAAGCTCATTTGCAATAT
CTAAGGGACTTTAAATGAACTTCAACCGCTTCAAGTGATACGTTGAGCGCATTGATAATACTAAGCAAGA
TTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCTAAACAAAGCA
GTCTAGAAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAAACCTTAGCTAACGAAAAGGAA

SEQUENCE LISTING

TATCGCCACTTAGACGAAGATATAGCTACTGTGCCGTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAA
ACCGCTATCATATAGTAAGATAGATACTACTCGCTTGTTC AAGAAATGGTTAAAGAAACGAAACAACCTAT
TAGAAGCTTCAGCAAGATTAGCTGCTGAAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGGCCAAAACCTCT
GAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGATTACTCAGCCCTCATCTAAGACATC
TTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTTGATGTTGATGAAAGTACTCAAAGTGGGCGG
CACTCGAGCACCACCACCACCACCAC

SEQ ID NO: 30 amino acid sequence comprising HIS-40a CH

M A S S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T
I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I
N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G
A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E E Q K A S I S
A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A
A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E
L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K
A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I
A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L
A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S
Y K K T H G N T R P S E V Y G Q P G V S G H Y G V G P H D K T I I E D S
A G A S T G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S
I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N P N A P V Y L G
F S T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G
S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E
A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D
T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A
L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N
R L Q S V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K
Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T
V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q E M V K E T K Q
L L E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K
I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V D E S T Q R A A
A L E H H H H H H

SEQ ID NO: 31 polynucleotide sequence comprising HIS-40a-RR NH

ATGGGATCGCATCACCATCACCATCAGCTAGTAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAG
AGCCTCAGGAGAAACGAAGGCGAGTAATACTCAGCAGATAGTTTACCAAACAGAAACAATTCAAGAGG
CAAAGGCAACTATTGATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACC
GCTCTGACAAAAACTACTGCTGAAATCAACCACCTAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAAC
CTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGGAGGAGACGCTATTAGCCCAAGGAGCCGAAC
ATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACT
GCATTGTCAGAACAAAAGCTAGCATTTCAGCAGAAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAA
AACGTCGAAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTC
AAACGGCTAATGATAATACAAAAGCATTAAAGCTCAGAATTTGGAGAAGGCTAAAGCTGACTTAGAAAATCAA
AAAGCTAAAGTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAAGCTGCTCTAGCAGAAAAGAGGC
AGAAGTTAGTCGCTTTAAATCCTCAGCTCCGCTACTCAAGATAGCATGTGGGTAATAATACCATGAAAG
CACCGCAAGGCTATCTCTTGAAGAACTTAAAAAATFAGAAGCTAGTGGTTATATTGGATCAGCTAGTTAC
AATAATTATTACAAAGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATA
CCAAGATATTCCAGCAGATCGTAATCGCTTTGTTGATCCCAGATAATTTGACACCAGAAGTGCAAAATGAGC
TAGCGCAGTTTGCAGCTCACATGATTAATAGTGTAGGCTCAATTAGGCTACCACCAGTTACTGTTACA
GCAGGATCACAAGAATTTGCAAGATTACTTAGTACCAGCTATAAGAAAACTCATGGTAATACAAGACCATC
ATTTGCTTACGGACAGCCAGGGGTATCAGGGCATTATGGTGTGGGCTCATGATAAAACTATTATTGAAG
ACTCTGCCGGAGCGTCAGGGCTCATTCGAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGAT
GTGCATACTGTGAATGGTATTAAACGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTT
ACACGGAAATACATACCGCCATGCTATTAACTTTTACGTGTAGATAAACATAACCCTAATGCGCCTGTTT
ACCTTGATTTTCAACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGCTAACATT
GCTAACCATCAACGCTTTAATAAGACCCCTATAAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGT

SEQUENCE LISTING

AGGCACTGTATCTGATACTATTGTCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGGCTA
TTCATCAAGAAGCTGATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACA
CTTAAGCAGTCAGACAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAAGTTCTTTGAGAACAGA
ATTACTAGCAGCTAAAGCAAAACAAGCACAACTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCAT
CGTTGAAAGCCGCACTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGCAGCCAGAGTGACAGCACTGGTG
GCTAAAAAAGCTCATTTGCAATATCTAAGGGACTTTAAATTGAATCCTAACCGCCTTCAAGTGATACGTGA
GCGCATTGATAATACTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAG
CAGCCTTACAAGCTAAACAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACACCAGTTGACTTTGCTT
AAAACCTTAGCTAACGAAAAGGAATATCGCCACTTAGACGAAGATATAGTACTGTGCCTGATTTGCAAGT
AGTCCACCTCTTACGGGCGTAAAACCGCTATCATATAGATAGATACTACTCCGCTTGTTCAGAAA
TGGTTAAAGAAACGAAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCA
GAAGCGCTTGTGGCCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGTCTAAAATCACATCTTCGAT
TACTCAGCCCTCATCTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTG
ATGAAAGTACTCAAGt

SEQ ID NO: 32 amino acid sequence comprising HIS-40a-RR NH

M G S H H H H H H A S S V G V S H Q V K A D D R A S G E T K A S N T H D
D S L P K P E T I Q E A K A T I D A V E K T L S Q Q K A E L T E L A T A
L T K T T A E I N H L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S
E E T L L A Q G A E H Q R E L T A T E T E L H N A Q A D Q H S K E T A L
S E Q K A S I S A E T T R A Q D L V E Q V K T S E Q N I A K L N A M I S
N P D A I T K A A Q T A N D N T K A L S S E L E K A K A D L E N Q K A K
V K K Q L T E E L A A Q K A A L A E K E A E L S R L K S S A P S T Q D S
I V G N N T M K A P Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y
K E H A D Q I I A K A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L
T P E V Q N E L A Q F A A H M I N S V R R Q L G L P P V T V T A G S Q E
F A R L L S T S Y K K T H G N T R P S F R V Y G Q P G V S G H Y G V G P H
D K T I I E D S A G A S G L I R N D D N M Y E N I G A F N D V H T V N G
I K R G I Y D S I K Y M L F T D H L H G N T Y G H A I N F L R V D K H N
P N A P V Y L G F S T S N V G S L N E H F V M F P E S N I A N H Q R F N
K T P I K A V G S T K D Y A Q R V G T V S D T I A A I K G K V S S L E N
R L S A I H Q E A D I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N
L Q V R Q L N D T K G S L R T E L L A A K A K Q A Q L E A T R D Q S L A
K L A S L K A A L H Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L
R D F K L N P N R L Q V I R E R I D N T K Q D L A K T T S S L L N A Q E
A L A A L Q A K Q S S L E A T I A T T E H Q L T L L K T L A N E K E Y R
H L D E D I A T V P D L Q V A P P L T G V K P L S Y S K I D T T P L V Q
E M V K E T K Q L L E A S A R L A A E N T S L V A E A L V G Q T S E M V
A S N A I V S K I T S S I T Q P S S K T S Y G S G S S T T S N L I S D V
D E S T Q R

SEQ ID NO: 33 polynucleotide sequence comprising 40N-HIS

ATGCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATACTCACGACGATAGTTACC
AAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAAATCTCAGTCAACAAAAG
CAGAACTGACAGAGCTTGCCTACCGCTCTGACAAAAACTACTGCCTGAAATCAACCCTTAAAAGAGCAGCAA
GATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAATTTACACTAATACTCTTGCAAGTAGTGAGGAGAC
GCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAGAGCTTCATAATGCTCAAG
CAGATCAACATTCAAAAGAGACTGCATTGTGAGAACAAAAGCTAGCATTTCAGCAGAACTACTCGAGCT
CAAGATTTAGTGAACAAGTCAAACCGTCTGAACAAAATATTGCTAAGCTCAATGCTATGATTAGCAATCC
TGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAAGCATTAAGCTCAGAATTGGAGAAGG
CTAAAGCTGACTTAGAAAATCAAAGGCTAAAGTTAAAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAA
GCTGGCTTAGCAGAAAAAGAGGCAGAACCTTAGTCGTCTTAAATCCTCAGCTCCGCTACTCAAGATAGCAT
TGTGGTAATAATACCATGAAAGCACCAGGCTATCCTCTTGAAGAATTAATAAATTAGAAAGCTAGTG
GTTATATTGGATCAGCTAGTTACAATAATTATCAAAAGCATGCAGATCAAATTATTGCCAAAGCTAGT
CCAGGTAATCAATTAATCAATACCAAGCGGCGCACTCGAGCACCACCACCACCACC

SEQUENCE LISTING

SEQ ID NO: 34 amino acid sequence comprising 40N-HIS

M Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I
 D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D
 N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T
 A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D
 L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T
 K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L
 A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E
 E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q
 L N Q Y Q A A A L E H H H H H H H

SEQ ID NO: 35 amino acid sequence comprising GAS 117

MTLKKHYLLSLLALVTVGAAFNFSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDL
GRHYSSYYYNLRVTVMGLSSEQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 36 polynucleotide sequence encoding GAS 117

ATGACACTAAAAAACACTATFATCTTCTCAGCCTGCTAGCTCTTGTAACGGTTGGTGCTGCCTTTAACAC
 AAGCCAGAGTGTCAAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGACTGATGAAAAATCAC
 ACCTGCAATATAGTAAAGACAACGCACAACCTTCAATTGAGAAATATCCTTGACGGCTACCAAAATGACCTA
 GGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCAAGTGAGCAAGACAT
 TGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATTAA

SEQ ID NO: 37 amino acid sequence comprising GAS 117 leader sequence

TLKKHYLLSLLALVTVGA

SEQ ID NO: 38 amino acid sequence comprising fragment of GAS 117 where leader sequence is removed

AFNFSQSVSAQVYSNEGYHQHLTDEKSHLQYSKDNAQLQLRNILDGYQNDLGRHYSSYYYNLRVTVMGLSS
 EQDIEKHYEELKNKLHDMYNHY

SEQ ID NO: 39 amino acid sequence comprising GAS 130

MSHMKKRPEVLSFAGTLEKLVKVAIDYGADAVFVGGQAYGLRSRAGNFSMEELQEGIDYAHARGAKVYVAAN
 MVTHEGNEIGAGWEFRQLRDMGLDAVIVSDPALIVICSTEAPGLEIHLSTQASSTNYETFEFWKAMGLTRV
 VLAREVNMAELAEIRKRTDVEIEAFVHGAMCISYSGRCVLSNHMSHRDANRGGCSQSCRWKYDLYDMPFGG
 ERRSLKGEIPEYDSSVDMCMIDHIPDLIENGVDLSKIEGRMKSIIHYVSTVTNICYKAAVGAAYMESPEAFY
 AIKEELIDELWKVAQRELATGFYGIPTENEQLFGARRKIPOYKFVGEVVAFDSASMTATIRQRNVIMEGD
 RIECYGPGFRHFETVVKDLHDADGQKIDRAPNPMELTTISLPREVKPGDMIRACKEGLVNLVYQKDGTSKTV
 RT

SEQ ID NO: 40 polynucleotide sequence encoding GAS 130

ATGTCACATATGAAAAACGTCCTCCGAGGTCCTTATCACCTGCTGGAACACTTGAAAAATTTAAAGTTGCGAT
 TGACTATGGCGCAGATGCTGTTTTTGTGGAGGGCAGGCCTATGGCCTAAGAAGCCGCGCTGGTAACCTTCT
 CTATGGAAGAATPGCAAGAAGGCATTGATTATGCACATGCCGCTGGAGCTAAGGCTATGTTGCTGCTAAC
 ATGGTTACCCACGAAGGGAACGAAATGGTGCGGGCGAGTGGTTTTCGTCAACTGCGTGATATGGGGCTTGA
 TGCGGTCATTGTTTCAGATCCAGCCTTGATTGTTATTTGTTCAACAGAAGCCCCAGGTTTGGAATTCATT
 TGTCAACGCAAGCTTCATCTACCAATTACGAGACCTTTGAATTTTGAAAGCCATGGGCTTGACCCGAGTT
 GTTTTAGCTCGGAGGTTAATATGGCCGAGTTAGCAGAAATCCGCAAGCGGACAGATGTGGAATTTGAAGC
 CTTTTGTCATGGAGCCATGTGTATCTCTTATTACAGCCGCTGTGTTTTGTCAAACCACATGAGTCACCGTG
 ATGCCAACAGGGGCGGCTGCTCACAGTCTTGCCGCTGGAAGTATGATTTGTATGACATGCCATTTGGAGGA
 GAGCGCCGCTCCTTAAAAGGGGAAATTCAGAAGACTATTCTATGCTCTCTGTTGACATGTGTATGATTGA
 CCATATTCCTGACCTGATTGAAAATGGGGTTGATAGCTTAAAAATTTGAAGCCGAATGAAATCTATCCACT
 ACGTCTCAACCGTACTGTTACAAGGCGGCTGATAGCTTACATGGAAGCCGAGTTGGCTACAGCTTTTTTAT
 GCTATCAAAGAGGAATTGATTGACGAGTTGTGGAAGGTTGCCAGCGGAGTTGGCTACAGCTTTTTTATTA
 TGGTATCCCAACTGAAAATGAACAATTATTTGGTGCTCGCCGCAAAATTCACAATATAAATTTGTCCGGAG
 AAGTAGTTGCCCTTGACTCAGCTAGCATGACAGCGACCATTTCGTACGGTAATGTCATCATGGAAGGCGAT

SEQUENCE LISTING

CGGATTGAATGTTATGGACCAGGTTCCGTCATTTTGAACGGTTGTTAAGGACTTACATGATGCGGATGG
 CCAAAGATTGACCGTGCCCCAAATCCAATGGAACCTTTAACCATCTTTTACCGAGAGAAGTTAAGCCAG
 GGGATATGATTAGGGCTTGCAAGGAAGTCTGGTTAACCTCTATCAAAAAGATGGCACCAGTAAACTGTT
 AGAACATAG

SEQ ID NO: 41 amino acid sequence comprising GAS 277

MTTMQKTI SLLSLALLI GLLGTS GKAI SVYAQDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV
 RQPTQATITLKDASDNTINSWVYTMAAQRRFTAWFDLTGQKSGDYHVTVVHTQEKAVTGQSGTVHFDQN
 KARKTPTNMQKDTSKAMTNSVDVDTKAQTNQSANQEIDSTSNNPFRSATNHRSTSLKRSTKNEKLTPTASN
 SQKNGSNKTKMLVDKEEVKPTSKRGFPWVLLGLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 42 polynucleotide sequence encoding GAS 277

ATGACAACATATGCAAAAAACAATTAGCTTATTATCAC TAGCTTTACTTATTGGTTTGCTGGGGACTTCTGG
 CAAAGCCATATCTGTGTATGCACAAGATCAGCACACTGATAATGTTATAGCTGAATCAACTATTAGTCAGG
 TCAGTGTGTAAGCCAGTATGCGTGGAACAGAACCCTTATATTGATGCTACAGTCACCACAGATCAACCTGTC
 AGACAACCAACTCAGGCAACGATAACACTTAAAGACGCTAGTGATAATACTATTAATAGTTGGGTATATAC
 TATGGCAGCGCAACAGCGCTGTTTACAGCTTGGTTTGATTTAAC TGGACAAAAGAGTGGTGACTATCATG
 TAACTGTCACCGTTCATACTCAAGAAAAGGCAGTAACTGGTCAATCAGGAAC TGTTCATTTTGATCAAAAC
 AAAGCTAGAAAAACCAACTAATATGCAACAAAAGGATACCTTCAAAGCAATGACGAATTCAGTCGATGT
 AGACAAAAAGCTCAAACAAATCAATCAGCTAACCAAGAAATAGATTCTACTTCAAATCCTTTCAGATCAG
 CTACTAATCATCGATCAACTTCCCTTAAAGCGATCTACTAAAAATGAGAAACTTACACCAACTGCTAGTAAT
 AGCCAAAAAACGGTAGCAACAAGACAAAAATGCTAGTGGACAAAGAGGAAGTAAACCTACTTCAAAAAG
 AGGATTCCCTTGGGTCTTATTAGGTCTAGTAGTCAGTTTAGCTGCAGGTTTATTATTATAGCTATTCAAAAAG
 TATCTAGACGAAAATAA

SEQ ID NO: 43 amino acid sequence comprising N-terminal leader sequence of GAS 277

TTMQKTI SLLSLALLI GLLGTS GKAI SVYA

SEQ ID NO: 44 amino acid sequence comprising fragment of GAS 277 where N-terminal leader sequence is removed

QDQHTDNVIAESTISQVSVEASMRGTEPYIDATVTTDQPV RQPTQATITLKDASDNTINSWVYTMAAQRR
 FTAWFDLTGQKSGDYHVTVVHTQEKAVTGQSGTVHFDQNKARKTPTNMQKDTSKAMTNSVDVDTKAQTN
 QSANQEIDSTSNNPFRSATNHRSTSLKRSTKNEKLTPTASNSQKNGSNKTKMLVDKEEVKPTSKRGFPWVLL
 GLVVS LAAGLFIAIQVSRRK

SEQ ID NO: 45 amino acid sequence comprising GAS 236

MTQMNYTGKVKRVAIIANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELD
 KRVFVGIHTGHLGFYTDYRDFEVDKLI DNLRKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKT
 MVADVII NHVKFESFRGDGISVSTPTGSTAYNKS LGGAVLHPTIEALQLTEISSLN RVFRTL GSSIIIPK
 KDKIELVPKRLGIYTTISIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 46 polynucleotide sequence encoding GAS 236

ATGACACAGATGAATTATACAGGTAAGGTAAAACGAGTTGCTATTATTGCAAATGGTAAAGTACCAAAGTAA
 ACGCGTCGCCTCCAACTTTTCTCCGTATTTAAAGATGATCCTGATTTCTATCTTTCAAAGAAAAATCCGG
 ATATTGTGATTTCTATTGGCGGAGATGGGATGCTCTTATCTGCCTTTCACATGTATGAAAAAGAATTAGAT
 AAGGTACGTTTTGTAGGAATCCACACCGGTCATCTTGGCTTTTATACCGATTATAGGGATTTGAAAGTTGA
 TAAATTAATTGATAATTTAAGAAAAGACAAGGGAGAACAATCTCTTATCCGATTTAAAAGTTGCTATTA
 CTTTAGATGATGGTCGTGTGGTTAAAGCGCGTGCTTTGAAATGAAGCGACGGTTAAGCGTATTGAAAAACG
 ATGGTAGCAGATGTTATTATTAACCATGTCAAATTTGAAAGCTTCCGAGGTGATGGGATTTTCAGTATCGAC
 CCCGACAGGGAGCACACCTACAATAAATCTTTAGTGGTGTCTTGCATCCGACGATTTGAAGCGCTGC
 AATTGACGGAAATTTCCAGCTTAATAACCGTGTCTTTAGAACCTTGGGCTCATCAATCATTTATCCAAA
 AAAGATAAGATTGAGTTAGTGCCAAAACGATTAGGAATTTATACCATTTCCATTGATAATAAACCTATCA
 GTTAAAAAATGTGACGAAGGTGGAGTATTTTATCGACGATGAGAAAATTCATTTTGTTCCTCTCCGAGTC
 ATACGAGCTTTTGGGAAAGGGTCAAGGATGCCTTTATTGGAGAGATTGACTCATGA

SEQUENCE LISTING

SEQ ID NO: 47 amino acid sequence comprising N-terminus leader sequence of GAS 236
 MTQM

SEQ ID NO: 48 amino acid sequence comprising a fragment of GAS 236 where the N-terminal leader sequence is removed

NYTGKVKRVAI IANGKYQSKRVASKLFSVFKDDPDFYLSKKNPDIVISIGGDGMLLSAFHMYEKELDKVRF
 VGIHTGHLGFYTDYRDFEVDKLDLNLKDKGEQISYPILKVAITLDDGRVVKARALNEATVKRIEKTMDVAD
 VIINHVKFESFRGDGIVSVSTPTGSTAYNKSLGGAVLHPTIEALQLTEISSLNNRVFRTLGSSIIIPKKDKI
 ELVPKRLGIYTI SIDNKTYQLKNVTKVEYFIDDEKIHVSSPSHTSFWERVKDAFIGEIDS

SEQ ID NO: 49 amino acid sequence comprising GAS 389

MRNEMAKIMNVTGEEVIALAATYMTKADVAFVAKALAYATAAHFYQVRKSGEPYIVHPIQVAGILADLHLD
 AVTVACGFLHDVVEDTDITLDEIEADFGHDARDIVDGVTKLGEVEYKSHEEQLAENHRKMLMAMSKDIRVI
 LVKLABRLHNMRTLKHLRDKQERISRETMEIYAPLAHRLGISRIKWELEDLAFRYLNETEFYKISHMMKE
 KRREREALVEAIVSKVKTYTTQQLFGDVYGRPKHIYSIYRKMMDKKRFDQIFDLIAIRCVMETQSDVYA
 MVGYIHLEWRPMPGRFKDYIAAPKANGYQSIHTTVYGPKGPIEQIRTKDMHQVAEYGVAAHWAYKKGVVRG
 KVNQAEQAVGMNWIKELVELQDASNGDAVDFVDSVKEDIFSERIYVFTPTGAVQELPKESGPIDFAYAIHT
 QIGEKATGAKVNGRMVPLTAKLKTGDVVEIITNANSFGPSRDWVVKLVKTNKARNKIRQFFKNQDKELSVNK
 GRDLLVSYFQEQGYVANKYLDKKRIEAILPKVSVKSEESLYAAVGFVDI SPI SVFNKLTEKERREEERAKA
 KAEAEELVKGGEVKHENKDVVKVRSNGVI IQGASGLLMRIAKCCNPVPGDPIDGYITKGRGIAIHRSDCH
 NIKSQDGYQERLIEVEWDLDNSKDYQAEIDYGLNRSGLLNDVLQILSNSTKSI STVNAQPTKDMKFANI
 HVSFGI PNLTHLTTVVEKIKAVPDVYSVKRTNG

SEQ ID NO: 50 polynucleotide sequence encoding GAS 389

ATGAGGAACGAAATGGCAAAAATAATGAACGTAACAGGAGAAGAAGTCATTGCCTTAGCGGCCACCTATAT
 GACCAAGGCTGATGTGGCTTTTGTGGCAAAGGCTTTAGCATATGCAACAGCGGCCCATTTCTACCAAGTGA
 GAAAGTCAGGCGAACCCATATATCGTCCATCCGATTCAGGTGGCGGGGATTCTGGCTGATTTGCATCTGGAT
 GCTGTGACAGTTGCTTGTGGCTTTTTACATGATGTCGTAGAAAGATACGGATATTACCTTAGATGAGATCGA
 AGCAGACTTTGGCCATGATGCTCGTGATATCGTTGATGGTGTCCACCAAGTTAGGTGAAGTTGAGTACAAAT
 CTCATGAGGAGCAACTCGCCGAAAACCATCGCAAATGCTGATGGCTATGTCCAAAGATATTCGCGTGATT
 TTGGTGAAATTGGCTGACCGCCTGCATAATATGCCGCAACCCCTCAAACATTTGCGCAAGGACAAACAAGCG
 CATTTCGCGCGAAACCATGGAAATCTATGCCCCCTTGGCGCATCGTTTGGGGATTAGTCGCATCAAATGGG
 AACTAGAAGATTTGGCTTTTTCGTTACCTCAATGAAACCGAATTTTACAAAATTTCCCATATGATGAAAAGAA
 AAACGTCGCGAGCGTGAAGCTTTGGTAGAGGCTATTGTTCAGTAAGGTCAAACCTATACGACACAACAAGG
 GTTGTGGAGATGTGTATGGCCGACCAAAACACATTTATTCGATTTATCGGAAAATGCGGGACAAAAGA
 AACGATTCGATCAGATTTTGTGATCTGATGCCATTCGTTGTGTGATGGAAACGCAAAGCGATGCTATGCT
 ATGGTTGGCTATATTCATGAGCTTTGGCGTCCATGCCAGGCCGCTTCAAGGATTTATATTGCAGCTCCTAA
 AGCTAATGGCTACCAGTCTATTCATACCACCGTGTATGGGCCAAAAGGACCTATTGAGATTCAAATCAGAA
 CTAAGGACATGCATCAAGTGGCTGAGTACGGGGTTGCTGCTCACTGGGCTTATAAAAAAGGCGTGCGTGGT
 AAGGTCAATCAAGCTGAGCAAGCCGTTGGCATGAACGGATCAAAGAGCTGGTAGAATTGCAAGATGCCCTC
 AAATGGCGATGCAGTGGACTTTGTGGATTTCGGTCAAAGAAGACATTTTTTCTGAAACGGATTTATGCTTTA
 CACCGACAGGGGCCGTTACAGGATTACCAAAAGAATCAGGTCTATTGATTTTGCTTATGCGATCCATACG
 CAAATCGGTGAAAAAGCAACAGGTGCCAAAGTCAATGGACGTATGGTTCCTCTCACTGCCAAGTTAAAAAC
 AGGAGATGTGGTTGAAATCATCACCATGCCAATTCCTTTGGCCCTAGTCGAGACTGGGTAAAACCTGGTCA
 AAACCAATAAGGCTCGCAACAAAATTCGTCAGTTCCTTAAAAATCAAGACAAGGAATTTGTCAGTGAATAAA
 GGCCGTGATTTGTGGTGTCTTATPTTCAAGAGCAGGGCTACGTTGCCAATAAATACCTTGACAAAAAACG
 CATTGAAGCCATCCTTCCAAAAGTCAGTGTGAAGAGCGAAGAATCACTCTATGCAGCCGTTGGGTTTGGTG
 ACATTAGTCCATCAGTGTCTTTAACAAGTTAACCGAAAAAGAGCGCCGTGAAGAAGAAAGGGCCAAGGCT
 AAAGCAGAAGCTGAAGAATTGGTTAAGGGCGGTGAGGTCAAACACGAAAAACAAGATGTGCTCAAGGTTCCG
 CAGTGAATAAGGAGTCATTATCCAAGGAGCATCAGGCCTCTTGATGCGGATTGCCAAGTGTGTAATCCTG
 TACCTGGTGATCCTATTGACGGCTACATTACCAAGGGCGTGGCATTGCGATTCACAGATCGGACTGTTCAT
 AACATTAAGAGTCAAGATGGCTACCAAGAACGCTTGATTGAGGTGAGTGGGATTTGGACAATTCGAGTAA
 AGATTATCAGGCTGAAATGATATCTATGGGCTCAATCGTAGTGGTCTGCTTAATGATGTGCTCCAAATTT
 TATCAAACTCAACCAAGAGCATATCGACAGTCAATGCTCAGCCGACCAAGGACATGAAGTTTGCTAATATT
 CACGTGAGCTTTGGCATTCAAAATCTGACGCATCTGACCACTGTTGTGCAAAAAATCAAGGCAGTTCAGAA
 TGTTTATAGCGTGAAGCGGACCAATGGCTAA

SEQUENCE LISTING

SEQ ID NO: 51 amino acid sequence comprising GAS 504

MKTRITELLNIDYPIFQGGMAWVADGDLGAVSNAGGLGIIGGNAPKEVVKANIDRVKAITDRPFGVNM
 LLSPFADDIVDLVIEGVKVVTTGAGNPGKYMERLHQAGIIVVPVPSVALAKRMEKLGVDVIAEGMEAG
 GHIGKLTMSLVRQVVEAVSIPVIAAGGIADGHGAAAFMLGAEAVQIGTRFVAKESNAHQNFKDKILAA
 KDIDTVISAQVVGHFVRSIKNKLTSAYAKAEKAFBIGQKTATDIEEMGAGSLRHAVIEGDVVNGSVMAQI
 AGLVRKEESCETILKDIYYGAARVIQNEAKRWQSVSIEK

SEQ ID NO: 52 polynucleotide sequence encoding GAS 504

ATGAAAACACGTATTACAGAATTACTTAATATTGATTACCCCATTTTCAAGGAGGAATGGCTTGGGTTGC
 TGATGGTGATTTAGCAGGTGCAGTTTCTAATGC TGGTGGTTTAGGCATTATAGGTGGTGGCAATGCTCCA
 AAGAAGTCGTTAAAGCTAATATGATCGTGTCAAAGCTATTACTGATAGACCTTTGGGGTTAATATCATG
 CTTTTATCTCCTTTTGTCTGATGATATCGTTGATCTGGTCATTGAAGAAGGTGTTAAAGTAGTAACAACAGG
 CGCAGGAAATCCAGGAAAGTATATGGAAGACTGCACCAGGCGGTATAATCGTTGTTCTCTGTTGCCAA
 GCGTTGCGCTAGCCAAACGTATGGAAGACTTGGGGTAGATGCTGTTATTGCTGAGGGTATGGAAGCTGGA
 GGACATATTGGCAAGTTAACGACTATGCTTTTAGTAAGACAAGTTGTTGAAGCGGTTTCGATTCCTGTTCAT
 TGCGGCAGGTGGTATAGCTGATGTCATGGTGCAGCAGCAGCATTATGTTAGGAGCAGAGGCTGTTCAA
 TTGGAACCTCGCTTTGTTGTTGCTAAAGAATCCAATGCTCACCAAATTTTAAAGATAAAAATCTTAGCAGCA
 AAAGATATTGATACGGTGAATTCGCGCAGGTGTGGGCCACCCTGTCCGTTCTATFAAAAATAAATTGAC
 CTCAGCTTACGCTAAAGCAGAAAAGCATTTTAATTGGTCAAAAACAGCTACTGATATTGAAGAAATGG
 GACAGGATCGCTTCGACACGCTGTTATTGAAGCGCATGTAGTCAATGGATCTGTTATGGCTGGCCAAAT
 GCAGGGCTTGTGAGAAAAGAAGAAAGCTGTGAAACGATTTTAAAGATATTTATTATGGTGCAGCTCGTGT
 TATTCAAATGAAGCTAAGCGCTGGCAATCTGTTTCAATAGAAAAGTAG

SEQ ID NO: 53 amino acid sequence comprising GAS 509

MTKIYKTI TELVGQTP I I KLNRL I PNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGLISPGDVIEE
 P TSGNTGIGLAWVGAAGYRVIIVMPETMSLERRQIIQAYGAEVLVTPGAEGMKGAIKAETLAIELGAW
 MPMQFNPNANPSIHEKTTAQEILEAFKEISLDAFVSGVGTGGT LSGVSHVLKKNPETVIYAVEAESAV
 LSGQEPGPHKIQGISAGFIPNTLDTKAYDQIIRVKS KDALETARLTGAKEGFLVGISSGAALYAAIEVAK
QLGKGKHLVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 54 polynucleotide sequence encoding GAS 509

ATGACTAAAATTTACAAAACATAACAGAATTAGTAGGTCAAAACACCTATTATCAAACCTAACCGTTTAA
 TTCCAAACGAAGCTGCTGACGTTTATGTAATAATTAGAAGCTTTTAAACCAGGATCTTCTGTTAAAGATCG
 TATTGCTTTATCGATGATTGAAGCTGCTGAAGCTGAAGTCTGATAAGTCTGGTGACGTTATTATCGAA
 CCAACAAGTGGTAATACAGGTATTGGTCTTGATGGGTAGGTGCTGCTAAAGGGTATCGAGTCATTATTG
 TTATGCCCGAAACTATGAGCTTGGAAAGACGGCAAATCATTACAGGCTTATGGTGCAGAGCTTGTCTTAAC
 ACCTGGAGCAGAAGGTATGAAAGGGGCTATTGCAAAAAGCTGAAACTTTAGCAATAGAACTAGGTGCTTGG
 ATGCCATATGCAATTTAATAACCCCTGCCAATCCAAGCATCCATGAAAAACAACAGCTCAAGAAATTTTGG
 AAGCTTTTAAGGAGATTTCTTTAGATGCATTCGTATCTGGTGTGGTACTGGAGGAACACTTTCTGGTGT
 TTCACATGCTTTGAAAAAGCTAACCCCTGAAACTGTTATCTATGCTGTTGAAGCTGAAGAATCTGCTGTC
 TTATCTGGTCAAGAGCCTGGACCACATAAAATCAAGGTATATCAGCTGGATTTATCCCAAACACGTTAG
 ATACCAAAGCCTATGACCAAATATCCGTGTTAAATCGAAAGATGCTTTAGAACTGCTCGACTAACAGG
 AGCTAAGGAAGGCTTCTGGTTGGGATTTCTTCTGGAGCTGCTCTTTACGCCGCTATTGAAGTCGCTAAA
CAGTTAGGAAAAGGCAAACATGTGTTAACTATTTACCAGATAATGGCGAACGCTATTTATCGACTGAAC
TCTATGATGTACCAGTAATTAAGACGAAATAA

SEQ ID NO: 55 amino acid sequence comprising C-terminus transmembrane region of GAS 509

FLVGISSGAALYAAIEVAKQLGKGKHLVLTILPDNGERYLSTELYDVPVIKTK

SEQ ID NO: 56 amino acid sequencing comprising a fragment of GAS 509 where the C-terminal transmembrane region is removed

MTKIYKTI TELVGQTP I I KLNRL I PNEAADVYVKLEAFNPGSSVKDRIALSMIEAAEAEGLISPGDVIEE
 P TSGNTGIGLAWVGAAGYRVIIVMPETMSLERRQIIQAYGAEVLVTPGAEGMKGAIKAETLAIELGAWMP

SEQUENCE LISTING

**MQFNPNANPSIHEKTTAQEILEAFKEISLDAFVSGVGTGGTSLGSVSHVLLKKNPETVIYAVEABESAVLSG
QEPGPHKIQGISAGFIPNTLDTKAYDQIIRVKSFDALETARLTGAREG**

SEQ ID NO: 57 amino acid sequence comprising GAS 366

**MKVISNFQNKILILGLAKSGEAAAKLLTKLALVTVNDKPFQNPAAQALLEEGIKVICGSHPVVELLDE
NFEYMKVKNPGIPYDNPMVKRALAKEIPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSAL
LSGNIGYPASKVVQKAIAGDTLVMELSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSFEDYVAAKWMIQAQ
MTESDYLILNANQEI SATLAKTTKATVIFPSTQKVVDGAYLKDGI LYFKEQAI IAATDLGVPGSHNIENAL
ATI AVAKLSGIADDIIAQCLSHFGGVKHLRQRVGQIKDITFYNDSKSTNILATQKALSGFDNSRLIL IAGG
LDRGNEFDDLVPDLLGLKQMIILGESABERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANAS
SWDMYPNFEVRGDEFLATFDCLRGDA**

SEQ ID NO: 58 polynucleotide sequence encoding GAS 366

**ATGAAAGTGATAAGTAATTTTCAAAAACAAAAAATATTAATATTGGGGTTAGCCAAATCGGGCGAAGCAGC
AGCAAATTATTGACCAAACCTGGTGCTTTAGTGACTGTTAATGATAGTAAACCATTGACCAAATCCAG
CGGCACAAGCCTTGTGGAAAGAGGGGATTAAGGTCATTTGTGGTAGCCACCCAGTAGAATTATTAGATGAG
AACTTTGAGTACATGGTTAAAAACCTGGGATTCCTTATGATAATCCTATGGTTAAACGCGCCCTTGCAA
GGAAATCCCATCTTGACTGAAGTAGAATGGCTTATTTCTGATCTGAAGCGCCTATTATCGGGATTACAG
GATCAAACGGGAAGACAACCACAACGACAATGATTGCCGATGTTTTGAATGCTGGCGGGCAATCTGCACTC
TTATCTGGAAACATTGGTTATCTCTGCTTCAAAAAGTTGTTCAAAAAGCAATTGCTGGTGATACTTTGGTGAT
GGAATTGTCCTCTTTTCAATTAGTGGGAGTGAATGCTTTTCGCCCTCATATTGCTGTCATCACTAATTTAA
TGCCGACTCACCTGGACTATCATGGCAGTTTTGAGGATTATGTTGCTGCTAAATGGATGATCAAGCTCAG
ATGACAGAATCAGACTACCTTATTTTAAATGCTAATCAAGAGATTTAGCAACTCTAGCTAAGACCACCAA
AGCAACAGTGATTCTTTTTCAACTCAAAAAGTGGTTGATGGAGCTTATCTGAAGGATGGAATACTCTATT
TTAAAGAACAGCGGATTATAGCTGCAACTGACTTAGGTGTCCAGGTAGCCACAACATGAAAATGCCCTA
GCAACTATTGCAGTTGCCAAGTTATCTGGTATTGCTGATGATATTATTGCCAGTGCCCTTTCACATTTTGG
AGGCGTTAAACATCGTTGCAACGGGTTGGTCAAATCAAAGATATTACCTTCTACAATGACAGTAAGTCAA
CCAATATTTTAGCCACTCAAAAAGCTTTATCAGGTTTTGATAACAGTCGCTTGATTTTGATTGCTGGCGGT
CTAGATCCGTGGCAATGAATTTGACGATTTGGTGCCAGACCTTTTAGGACTTAAGCAGATGATTATTTGGG
AGAATCCGCAGAGCGTATGAAGCGAGCTGCTAACAAAGCAGAGGCTCTTATCTTGAAGCTAGAAAATGTTG
CAGAAGCAACAGAGCTTGCTTTTAAAGCTGGCCAAACAGGCGATACTATCTTGCTTAGCCCAAGCAATGCT
AGCTGGGATATGTATCTTAATTTTGGAGGTTCTGGGGATGAATTTTGGCAACCTTTGATTGTTTAAAGAG
AGATGCCTAA**

SEQ ID NO: 59 amino acid sequence comprising N-terminal leader sequence of GAS 366

MKVISNFQNKILILGLAKSGEAAA

SEQ ID NO: 60 amino acid sequence comprising a fragment of GAS 366 where the N-terminal leader sequence is removed

**KLTKLALVTVNDKPFQNPAAQALLEEGIKVICGSHPVVELLDENFEYMKVKNPGIPYDNPMVKRALAKE
IPILTEVELAYFVSEAPIIGITGSNGKTTTTMIADVLNAGGQSALLSGNIGYPASKVVQKAIAGDTLVMEL
LSSFQLVGVNAFRPHIAVITNLMPTHLDYHGSFEDYVAAKWMIQAQMTESDYLILNANQEI SATLAKTTKA
TVIFPSTQKVVDGAYLKDGI LYFKEQAI IAATDLGVPGSHNIENALATI AVAKLSGIADDIIAQCLSHFGG
VKHLRQRVGQIKDITFYNDSKSTNILATQKALSGFDNSRLIL IAGGLDRGNEFDDLVPDLLGLKQMIILGE
SAERMKRAANKAEVSYLEARNVAEATELAFKLAQTGDTILLSPANASWDMYPNFEVRGDEFLATFDCLRGD
A**

SEQ ID NO: 61 amino acid sequence comprising GAS 159

**MRKLYSFLAGVLGVIVILTSLSFILQKKSGSGSQSDKLVIIYNWGDYIDPALLKFKTKETGIEVQYETFDNS
EAMYT~~KIKQGGTTYDIAVPSDYTIDKMIKENLLNKLDKSKLVGM~~DNIGKEFLGKSFDPONDYSLPYFWGTV
GIVYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLVGLTTFGYSVNSKNLEQLQAERKLQQLTPNV
KAIVADEMKGYMIQGDAAIGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNLF
INRPENAAQNAAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDIIKKLEVDNLGSRWLGIYNDLYLQFKMY
RK**

SEQUENCE LISTING**SEQ ID NO: 62** polynucleotide sequence encoding GAS 159

ATGCGTAAACTTTATTCCTTTCTAGCAGGAGTTTTGGGTGTTATTGTTATTTTAACAAGTCTTTCTTTTCAT
CTTGCAGAAAAAATCGGGTCTGGTAGTCAATCGGATAAAATTAGTTATTTATAACTGGGGAGATTACATTG
ATCCAGCTTTGCTCAAAAAATTCACCAAGAAACGGGCATTGAAGTGCAGTATGAAACTTTCGATTCCAAT
GAAGCCATGTACACTAAAATCAAGCAGGGCGGAACCACTTACGACATTGCTGTTCTTAGTGATTACACCAT
TGATAAAATGATCAAAAGAAAACCTACTCAATAAGCTTGATAAGTCAAATTAGTTGGCATGGATAATATCG
GGAAAGAATTTTTAGGGAAAAGCTTTGACCCACAAAACGACTATTCTTTGCCTTATTTCTGGGGAACCGTT
GGGATTGTTTATAATGATCAATTAGTTGATAAGGCGCCTATGCACCTGGGAAGATCTGTGGCGTCCAGAATA
TAAAAATAGTATTATGCTGATTGATGGAGCGCGTGAAATGCTAGGGGTTGGTTTAACAACCTTTGGTTATA
GTGTGAATTTCTAAAAATCTAGAGCAGTTGTCAGGCAGCCGAGAGAAAACCTGCAGCAGTTGACGCCGAATGTT
AAAGCCATTGTAGCAGATGAGATGAAAGGCTACATGATTCAAGGTGACGCTGCTATTGGAATTACCTTTTC
TGGTGAAGCCAGTGAATGTTAGATAGTAACGAACACCTTACTACATCGTGCCTTCAGAAGGGTCTAACC
TTTGGTTTGATAATTGGTACTACCAAAAACCATGAAACACGAAAAGAAGCTTATGCTTTTTTGAACCTT
ATCAATCGTCTGAAAATGCTGCGCAAAAATGCTGCATATATTGGTTATGCGACACCAAAATAAAAAAGCCAA
GGCCTTACTTCCAGATGAGATAAAAAATGATCCTGCTTTTTATCCAACAGATGACATTATCAAAAAATTTGG
AAGTTTATGACAATTTAGGGTCAAGATGGTTGGGGATTTATAATGATTTATACCTCCAATTTAAAATGTAT
CGCAAATAA

SEQ ID NO: 63 amino acid sequence comprising N-terminal leader sequence of GAS 159

MRKLYSFLAGVLGVIVILTSLFSI

SEQ ID NO: 64 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence is removed

LQKKSGSGSQSDKLVYINWGDYIDPALLKKFTKETGIEVQYETFDSNEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPQNDYSLPYFWGTGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKQQLTPNVKAIVADEMKGMYIQGDAAGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFINRPNENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVDNLGSRWLGIVYNDLYLQFKMYRK

SEQ ID NO: 65 amino acid sequence comprising C-terminal hydrophobic sequence of GAS 159

WLGIVYNDLYLQFKMYRK

SEQ ID NO: 66 amino acid sequence comprising a fragment of GAS 159 where the C-terminal hydrophobic region is removed

MRKLYSFLAGVLGVIVILTSLFSILQKKSGSGSQSDKLVYINWGDYIDPALLKKFTKETGIEVQYETFDSN
 EAMYTKIKQGGTTYDIAVPSDYTI DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPQNDYSLPYFWGTG
 VYNDQLVDKAPMHWEDLWRPEYKNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKQQLTPNV
 KAIVADEMKGMYIQGDAAGITFSGEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFINR
 PENENAAQNAAYIGYATPNKKAKALLPDEIKNDPAFYPTDDI IKKLEVDNLGSR

SEQ ID NO: 67 amino acid sequence comprising a fragment of GAS 159 where the N-terminal leader sequence and the C-terminal hydrophobic region is removed

LQKKSGSGSQSDKLVYINWGDYIDPALLKKFTKETGIEVQYETFDSNEAMYTKIKQGGTTYDIAVPSDYTI
 DKMIKENLLNKLDKSKLVGMDNIGKEFLGKSFDPQNDYSLPYFWGTGIVYNDQLVDKAPMHWEDLWRPEY
 KNSIMLIDGAREMLGVGLTTFGYSVNSKNLEQLQAAERKQQLTPNVKAIVADEMKGMYIQGDAAGITFS
 GEASEMLDSNEHLHYIVPSEGSNLWFDNLVLPKTMKHEKEAYAFNFINRPNENAAQNAAYIGYATPNKKAK
 ALLPDEIKNDPAFYPTDDI IKKLEVDNLGSR

SEQ ID NO: 68 amino acid sequence comprising GAS 217

MAQRIVITGASGGLAQAIKQLPKEDSLILLGRNKERLEHCYQHIDNKECLELDITNPVAIEKMVAQIYQ
 RYGRIDVLIINNAGYGAFKGFEEFSAQEIADMFQVNTLASIHFAFLIGQKMAEQGQGHLINIVSMAGLIASA
 KSSIYSATKFPALIGFNSALRLELADKGVYVTTVNPPIATKFFDQADPSGHYLESVVGKFTLQPNQVAKRLV
 SIIGKNKRELNLPFLAVTHQFYTLF PKLSDY LARKVFNKY

SEQ ID NO: 69 polynucleotide sequence encoding GAS 217

SEQUENCE LISTING

ATGGCACAAAGAATCATTGTTATCACGGGAGCTTCTGGAGGACTGGCTCAGGCAATTGTTAAGCAGTTACC
 CAAGGAAGACAGCTTGATTTTATTAGGACGTAACAAAGAACGCCCTAGAACACTGTTATCAGCATATTGACA
 ACAAGAATGCCTCGAGTTGGATATTACCAATCCAGTAGCCATTGAGAAAATGGTCGCCCAGATTTACCAG
 CGCTATGGCCGTATTGATGTCTTGATTAATAATGCTGGCTACGGAGCTTTCAAAGGCTTTGAAGAGTTTC
 TGCCCAAGAAATAGCTGATATGTTTCAGGTTAACACCCTAGCGAGCATTCACTTTGCTTGCTTGATTGGTC
 AGAAAATGGCAGAGCAGGGGCAAGGTCACCTTATTAATATTGTGTCCATGGCAGGCTTGATTGCGTCAGCC
 AAATCGAGCATTATTTCAGCCACCAAGTTTGCCCTTATCGGATTTTCCAATGCCCTTCGCTTAGAATTAGC
 GGATAAAGGGGTTTACGTGACCACCGTGAATCCAGGTCCCATTGCCACCAAGTTTTTTGACCAAGCTGACC
 CGTCTGGACATTATTTGAAAAGCGTTGGTAAATTTACTCTCCAACCAAAATCAAGTGGCTAAGCGTTTGGTT
 TCTATTATCGGGAAAAATAAACGAGAAATTGAATTTGCCCTTTAGTTTAGCGGTGACCCATCAATTTTACAC
 CCTTTTCCCTAAATTATCTGATTATCTTGCAAGAAAGGTATTTAATTATAAATGA

SEQ ID NO: 70 amino acid sequence comprising GAS 309

MIKEYLESSIESKQLIVLFFKTSYLPITEVAEKTGLTFLQLNHYCEELNAFFPGSLSMTIQKRMISCQFT
 HPFKETYLYQLYASSNVLQLLAFLIKNGSHSRPLTDFARSHFLSNSSAYRMREALIPLLRNFELKLSKNKI
 VGEYRIRYLIALLYSKFGIKVYDLTQQDKNTIHSFLSHSSTHLKTSFWLSESFYDILLALSWKRHQFS
 VTIPQTRIFQQLKLFVYDSLKSSHDI IETYCQLNFSAGDLDYLYLIYITANNSFASLQWTPHIRQYCQ
 LFEENDTFRLLLNPIITLLENLKEQKASLVKALMFFSKSFLNLFQHFIPETNLFVSPYKGNQKLYTSLKL
 IVEEWMAKLPKRDNLNKHFLFCHYVEQSLRNIQPLVVFVANSFINAHLTDSFPRYFSDKSIDFHSY
 YLLQDNVYQIPDLKPDLVITHSQLIPFVHHELTGKIAVAEISFDESILSIQELMYQVKEEFQADLTQKLT

SEQ ID NO: 71 polynucleotide sequence encoding GAS 309

TTGATAGAAAAATACTTGGAAATCATCAATCGAATCAAATGTGAGTAAATTGCTTGTTTTTTAAGACATC
 TTATTTGCCAATAACTGAGGTAGCAGAAAAAACTGGCTTAACCTTTTTACAACATAACCATTATTGTGAGG
 AACTGAATGCCTTTTTCCCTGGTAGTCTGTCTATGACCATCCAAAAAGGATGATATCTTGCCAATTTACA
 CATCCTTTTAAAGAACTTATCTTTACCAACTCTATGCATCATCTAATGTCTTACAATTACTAGCCTTTTT
 AATAAAAAATGGTCCCCTCTCGTCCCTTACGGATTTTGAAGAAGTCATTTTTTATCAAACCTCTCAG
 CTTATCGGATGCGCGAAGCATTGATTCCTTTATTAAGAACTTTGAATTAAACTCTCTAAGAACAAGATT
 GTCGGTGAGGAATATCGCATCCGTTACCTCATCGCTCTGCTATATAGTAAGTTTGGCATTAAAGTTTATGA
 CTTGACGCAGCAGACAAAAACACTATTCTATAGCTTTTTTATCCCATAGTTCACCCACTTAAAACCTCTC
 CTTGGTTATCGGAATCGTTTTCTTTCTATGACATTTTATTAGCTTTATCGTGGAAGCGGCATCAATTTTCG
 GTAACATTCCCAAACCAGAATTTTTCAACAATTAAAAAAACTTTTTGTCTACGATTCTTTGAAAAAAG
 TAGCCATGATATTATCGAAACTTACTGCCAACTAAACTTTTTCAGCAGGAGATTGGACTACCTCTATTTAA
 TTTATATCACCGTAATAATCTTTTTCGAGCTTACAATGGACACCTGAGCATATCAGACAATATTGTCAA
 CTTTTTGAAGAAAATGATACTTTTCGCCTGCTTTTAAATCCTATCATCACTCTTTTACCTAACCTAAAAGA
 GCAAAAGGCTAGTTTAGTAAAGCTCTTATGTTTTTTTCAAAATCATCTTGTTTAATCTGCAACATTTTA
 TTCTTGAGACCAACTTATTCGTTTCTCCGTACTATAAAGGAAACCAAAACTCTATACGTCCTTAAAGTTA
 CCACTATGTCGAGCAAAGTCTAAGAAATATCCAACCTCCTTTAGTTGTTGTTTTTCGTAGCCAGTAATTTTA
 TCAATGCTCATCTCCTAACGGATTCTTTTCCAAGGTATTTCTCGGATAAAAGCATTGATTTTTCATTCTAT
 TATCTATTGCAAGATAATGTTTATCAAATTCCTGATTTAAAGCCAGATTGGTTCATCACTCACAGTCAACT
 GATTCCTTTTGTTCACCATGAACCTACAAAAGGAATGCTGTGCTGAAATATCTTTTGATGAATCGATTC
 TGTCTATCCAAGAATTGATGTATCAAGTTAAAGAGGAAAAATCCAAGCTGATTTAACCAAGCAATTAACA
 TAA

SEQ ID NO: 72 amino acid sequence comprising GAS 372

MIQIGKLFAGRYRILKSI GRGGMADVYLANDLILDNEDVAIKVLRITNYQTDQVAVARFQREARAMAELNHP
 NIVAIRDIGEEDGQFLVMEYVDGADLKRYIQNHAPLSNNEVVRIMEEVL SAMTLAHQKGI VHRDLKPONI
 LLTKEGVVKVTFDFGI AVAFAETSLTQTNSMLG SVHYLSPEQARGSKATI QSDIYAMGIMLFEMLTGHI PYD
 GDSAVTIALQHFQKPLPSII EENHNVPQALENVVIRATAK KLSDRYGSTFEMSRDLMTALSYNRSRERKII
 FENVESTKPLPKVASGPTASVKLSPPTPTVLTQESRLDQTNQTDALQPPTKKKSGRFLGLTFKILFSFFI
 VGVALFTYLILTKPTS VKVPNVAGTSLKVAQELVDVGLKVGKIRQIESDTVAEGNVVVRTPKAGTAKRQG
 SSITLYVSI GNKGFDMENYKGLDYQEAMNSLIETYGVPKSKIKIERIVTNEY PENTVISQSPSAGDKFNP
 GKSKITLSVAVSDITMPMVTEYSYADAVNTLTALGIDASRIKAYVPSSSATGFVPIHSPSSKAI VSGQS
 PYYGTSLSLSDKGEISLYLYPEETHSSSSSSSSSTSSSNSSSINDSTAPGSNTELSPSETTSQTP

SEQUENCE LISTING

SEQ ID NO: 73 polynucleotide sequence encoding GAS 372

ATGATTCAGATTGGCAAATTTATTTGCTGGTCTGTTATCGCATTCTGAAATCTATTGGCCGCGGTGGTATGGC
GGATGTTTATTTAGCAAATGACTTGATCTTGATAATGAAGACGTTGCAATCAAGGCTTTGCGTACCAATT
ATCAAACAGATCAGGTAGCAGTTGCGCGTTTTCCAACGAGAAGCGCGGGCCATGGCTGAAATGAACCATCCC
AATATTGTTGCCATCCGGGATATAGGTGAAGAAGACGGACAGCAATTTTTAGTAATGGAATATGTGGATGG
TGCTGACCTAAAGAGATACATTCAAATCATGCTCCATTATCTAATAATGAAGTGGTTAGAATTTATGGAAG
AAGTCCTTTCTGCTATGACTTTAGCCCACCAAAAAGGAATTGTACACAGAGATTTAAAACCTCAAATATC
CTACTAACTAAGGAGGGTGTGTCAAAGTAACTGATTTCCGGCATCGCAGTAGCCTTTGCAGAAACAAGCTT
GACACAAACTAATTCGATGTTAGGCAGTGTTCATTACTTGTCTCCAGAACAGGCTCGCGGCTCCAAAGCGA
CGATTCAAAGTGATATTTATGCGATGGGGATTATGCTCTTTGAGATGTTGACAGGCCATATCCCTTATGAC
GGCGATAGTGCTGTTACGATTGCCCTTGCAACATTTTCAAAGCCCTTCCATCTATTATCGAGGAGAACCA
CAATGTGCCACAAGCTTTGGAGAATGTTGTTATTTCGAGCAACAGCCAAGAAATTAAGTGATCGTTACGGGT
CAACCTTTGAAATGAGTCGTGACTTAATGACGGCGCTTAGTTATAATCGTAGTCGGGAGCGTAAGATTATC
TTTGAGAAATGTTGAAAGTACCAAAACCCCTCCCAAAGTGGCCTCAGGTCCCACCGCTTCGTAAAATTGTC
TCCCCCTACCCCAACAGTGTAAACACAGGAAAGTCGATTAGATCAAACATAACAGATGCTTTACAGC
CCCCACCAAAAAGAAAAAAGTGGTCTGTTTTTTAGGTACTTTATCAAATCTTTTTTCTTTCTTTATT
GTAGGTGTAGCCTCTTTACTTATCTTATACTAACTAAACCAACTCTGTGAAAGTCCTAATGTAGCAGG
CACTAGTCTTAAAGTTGCCAAACAAGAAGTGTATGATGTTGGGCTAAAAGTGGGTAAAATCAGGCAAATTG
AGAGTGATACGGTTGCTGAGGAAATGTAGTTAGAACAAGATCTTAAAGCAGGAACAGCTAAGAGGCAAGGC
TCAAGCATTACGCTTTATGTGTCATTTGGAACAAGGTTTTCACATGGAACATAAAGGACAGTAGATTA
TCAAGAAGCTATGAATAGTTTGTATGAAACTTATGGTGTTCAAAAATCAAATCAAATTTAGCGCATTG
TAACTAATGAATATCTGAAAATACAGTCATCAGTCAATCGCCAAGTGCGGGTGATAAATTTAATCCAAAC
GGAAAGTCTAAAATTACGCTCAGTGTGCTGTTAGTGATACGATCACTATGCCATGGTAACAGAATATAG
TTATGCAGATGCAGTCAATACCTAACAGCTTTAGGTATAGATGCATCTAGAATAAAAGCTTATGTGCCAA
GCTCTAGCTCAGCAACGGGCTTTGTGCCAATTCATCTCCTAGTCTTAAAGCTATTGTGAGTGGTCAATCT
CCTTACTATGGAACGCTTTGAGTCTGTCTGATAAAGGAGAGATTAGTCTTTACCTTTATCCAGAAGAAAC
ACACTCTTCTAGTAGCTCATCGAGTTCAACGTCAGTTCAAACAGTCTTCAATAAATGATAGTACTGCAC
CAGGTAGCAACACTGAATTAAGCCCATCAGAACTACTTCTCAAACACCTTAA

SEQ ID NO: 74 amino acid sequence comprising GAS 39

MDLILFLLVLLVLLGLGAYLLFKVNLQHQLAQTLEGNADNLSQDMTYQLDTANKQQLLELTQLMNRQQAGL
YQQLTDIRDVLHRSLSRSRDRSDKRLEKINQVNVQSLKNMQESNEKRLKMRQIVEEKL EETLKNRHLHASF
DSVSKQLESVKNGLGEMRSVAQDVGTLNKVLNNTKTRGILGELQLGQI IEDIMTSSQYEREFVTVSGSSER
VEYAIKLPNGGQGGYIYLPIDSKFPLEDYRLEDAVEVGDKLAIEASRKALLAAIKRFAKDIHKKYLNPPE
TTFNGVMFLPTEGLYSEVVRNASFFDSLRRREENIVVAGPSTLSALLNSLSVGFKTLNIQKNADDISKILGN
VKLEFDKFGGLLAKAQKQMNNTANNTLDQLISTRNIVRALNVTVEYQDQATKSLNMLPLEEENEN

SEQ ID NO: 75 polynucleotide sequence encoding GAS 39

ATGGACCTTATCTTGTCTCTTTGGTCTTGGTCTCTCTAGGTTTAGGGGCTTATCTGTTGTTCAAAGTCAA
CGGCCCTCAACATCAGCTTGCCCAAACCTTAGAAGGCAACGCGGATAATTTGCTGACCAAATGACCTACC
AGTTGGATACAGCTAACAAACAACAATTGTTAGAGCTAACACAGCTGATGAACCGACAACAAGCAGGCCTT
TACCAACAATTAACAGATATTCGTGACGCTTGCACCGTAGTTTGTCTGATAGTAGGGACCGGTCTGACAA
ACGCTTAGAAAAAATTAACCAGCAGGTCAACCAATCGCTCAAAAATATGCAAGAATCTAACGAAAAACGTT
TGGAGAAAATGCGCCAGATCGTTGAAGAAAAATGGAAGAAACCTTAAAAATCGTCTGCACGCCTCTTTC
GATCTGTATCCAAGCAACTAGAAAAGTGTCAATAAAGGCTTGGGAGAAATGCGTAGCGTGGCTCAAGATGT
GGGTACTTTAAATAAGGTTTGTCCAATACCAAAACACGAGGCATTTTAGGCGAACTTCAACTAGGCCAAA
TCATTGAGGATATCATGACATCAAGCCAGTACGAAAGAGAAATTTGTAACGGTTAGTGGTTCTAGTGAACGC
GTAGAATATGCGATTAAAGCTCCAGGAAATGGTCAAGGCGGTTATATTTACCTACCGATTGACTCAAATTT
CCCTCTTGAAGATTATTACCGATTAGAAAGATGCTTACGAAGTTGGTGATAAACTGGCCATCGAGGCTAGCC
GAAAAGCACTTCTGGCAGCTATCAAACGCTTTGCCAAAGACATTCATAAAAAGTACTTGAACCCCCAGAG
ACGACCAATTTGCGAGTTATGTTCTTACCAACAGAAGGCTTTTATTCAGAAGTGGTCAGAAATGCGTCTTT
CTTTGATAGCCTTCGTCGGGAAGAAAATATGTTGGTTGCAGGCCCTTCGACCCTGTCTGCTTTGCTGAATT
CCTTATCTGTTGGTTTCAAGACCTTAAATATCCAAAAAATGCTGATGACATCAGTAAAATTTTAGGCAAT
GTCAAGTTAGAATTCGATAAATTTGGCGGCCCTGCTTGCCAAGGCTCAAAAACAAATGAATACAGCTAATAA
TACGCTGGATCAGCTCATTTCAAACAAGGACAAATGCCATTGTTTCGAGCCTTGAATACCGTTGAACTTATC
AAGACCAAGCAACAAATCTCTCTTGAACATGCCCTTATTAGAAGAGGAAAAATAATGAAAATTA

SEQUENCE LISTING

SEQ ID NO: 76 amino acid sequence comprising GAS 42

MTKEKLVAFSQAHAEPAWLQERRLAALAEIPNLELPTIERVKFHRWNLGDGTLTENESLASVPDFIAIGDN
PKLVQVGTQTVLEQLPMALIDKGVVFSDFYTALEEIPEVIEAHFGQALAFDEDKLAAYHTAYFNAAVLYV
PDHLEITTPIEAIFLQSDSDVPFNKHVLIAGKESKFTYLERFESIGNATQKISANISVEVIAQAGSQIK
FSAIDRLGPSVTTYISRRGRLEKDANIDWALAVMNEGNIADFDSDLIGQGSQADLKVVAASSGRQVQIGID
TRVTNYGQRTVGHILQHGVLERGLTFNGIGHILKDAKGADAQQESRVLMLSDQARADANPILLIDENEV
TAGHAASIGQVDPEDMYLMSRGLDQETAERLVIRGFLGAVIAEIPFPSVRQEIKVLDEKLLNR

SEQ ID NO: 77 polynucleotide sequence encoding GAS 42

ATGACAAAAGAAAACTAGTGGCTTTTTTCGCAAGCCCACGCTGAGCCTGCTTGGCTGCAAGAACGGCGTTT
AGCGGCATTAGAAGCCATTCCAAATTTGGAATTACCAACCATCGAAAGGGTTAAATTTCCACCGTTGGAATC
TAGGAGATGGTACC'TTAACAGAAAATGAAAGTCTAGCTAGTGTCCAGATTTTATAGCTATTGGAGATAAC
CCAAAGCTTGTTCAGGTAGGCACGCAAAACAGTCTTAGAACAGTTACCAATGGCGTTAATTGACAAGGGAGT
TGTTTTCAGTGATTTTTATACGGCGCTTGAGGAAATCCCAGAAGTAATTGAAGCTCATTGTTGGTCAGGCAT
TAGCTTTTTGATGAAGACAACTAGCTGCCTACCACACTGCTTATTTTAATAGCGCAGCCGTGCTCTACGTT
CCTGATCAC'TTGGAAATCACAACCTCCTATTGAAGCTATTTTCTTACAAGATAGTGACAGTGACGTTCCCTTT
TAACAAGCATGTTCTAGTGATTGCAGGAAAAGAAAAGTAAGTTCACCTATTTAGAGCGTTTTGAATCTATTG
GCAATGCCACTCAAAGATCAGCGCTAATATCAGTGTAGAAGTGATTGCTCAAGCAGGCAGCCAGATTAAA
TTCTCGGCTTACGACCGCTTAGGTCCTTCAGTGACAACCTATATTAGCCGTCGAGGACGTTTAGAGAAGGA
TGCCAACATTGATTGGGCCTTAGCTGTGATGAATGAAGGCAATGTCATTGCTGATTTTGACAGTGATTGA
TTGGTCAGGGCTCACAAAGCTGATTTGAAAGTTGTTGCAGCCTCAAGTGGTCGTCAGGTACAAGGTATTGAC
ACGCGCGTGACCAACTATGGTCAACGTACGGTCGGTCATATTTTACAGCATGGTGTGATTTTGGAAACGTGG
CACCTAACGTTTAAACGGGATTGGTCATATTTCTAAAAGACGCTAAGGGAGCTGATGCTCAACAAGAAAGCC
GTGTTTTGATGCTTTCTGACCAAGCAAGAGCCGATGCCAATCCAATCCTCTTAATTGATGAAAATGAAGTA
ACAGCAGGTGATGACGCTTCTATCGGTCAGGTTGACCCTGAAGATATGTATTACTTGTGAGTTCGAGGACT
GGATCAAGAAACAGCAGAACGATTGGTTATTAGAGGATTCCTAGGAGCGGTTATCGCTGAAATTCCTATTC
CATCAGTCCGCCAAGAGATTATTAAGGTTTTAGATGAGAAATTGCTTAATCGTTAA

SEQ ID NO: 78 amino acid sequence comprising GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMAHPVQAEVISKRDYMRFLGLDLEDDSANYPNLEARYKG
YLEGYEKGLKGGDDIPERPKIQVPEDVQPSDHDYRDGYEEGFEGEGQHKRDPLETEAEDDSQGGRQEGRQGH
QEGADSSDLNVEESDGLSVIDEVVGVIYQAFSTIWTYLSGLF

SEQ ID NO: 79 polynucleotide sequence encoding GAS 58

ATGAAATGGAGTGGTTTTATGAAAACAAAACAAAACGCTTTTTAAACCTAGCAACCCTTTGCTTGGCCCT
ACTAGGAACAAC'TTGTCAATGGCACATCCCCTACAGGCGGAGGTGATATCAAAAAGAGACTATATGACTC
GCTTCGGGTTAGGCGATTTAGAAGATGATTCAGCTAACTATCCTTCAAATTTAGAAGCTAGATATAAAGGA
TATTTAGAGGGATATGAAAAGGCTTAAAAGGAGATGATATACCCGAACGGCCCAAGATTCAGGTTCCCTGA
GGATGTTAGCCATCTGACCATGGCGACTATAGAGATGGTTATGAGGAAGGATTTGGAGAAGGACAACATA
AACGTGATCCATTAGAAAACAGAAGCAGAAGATGATTC'CAAGGAGGACGTCAAGAAGGACGTCAAGGACAT
CAAGAAGGAGCAGATTCTAGTGATTTGAACGTTGAAGAAAGCGACGGTTTGTCTGTTATTGATGAAGTAGT
TGGAGTAATTTATCAAGCATTAGTACTATTTGGACATACTTAAGCGGTTTGTCTTAA

SEQ ID NO: 80 amino acid sequence comprising N-terminal leader sequence of GAS 58

MKWSGFMKTKSKRFLNLATLCLALLGTTLLMA

SEQ ID NO: 81 amino acid sequence comprising a fragment of GAS 58 where the N-terminal leader sequence is removed

HPVQAEVISKRDYMRFLGLDLEDDSANYPNLEARYKGYLEGYKGLKGGDDIPERPKIQVPEDVQPSDHDG
DYRDGYEEGFEGEGQHKRDPLETEAEDDSQGGRQEGRQGHQEGADSSDLNVEESDGLSVIDEVVGVIYQAFS
TIWTYLSGLF

SEQ ID NO: 82 amino acid sequence comprising GAS 290

SEQUENCE LISTING

**MKHILFIVGSLREGSFNHQLAAQAQKALEHQAVVSYLNNWKDVPVLNQDIEANAPLPVVDARQAVQSADAIW
IFTFVYNFSIPGSVKNLLDWLSRALDLSDFTPGSAIGGKVVTVSSVANGGHDQVFDQFKALLPFIRTSVAG
EFTKATVNPDAWGTGRLEISKETKANLLSQAEALLAAI**

SEQ ID NO: 83 polynucleotide sequence encoding GAS 290

ATGAAACATATTTTATTATTGTTGGCTCGCTTCGTGAAGGGCTTTTAACCATCAATTAGCGGCTCAAGC
ACAAAAGCTCTGGAACATCAAGCAGTTGTATCTTACTTAAATTGGAAAGACGTTCCCTGTTTTGAATCAAG
ATATCGAAGCTAATGCACCTTTACCAGTTGTTGACGCTCGTCAAGCTGTTTCAGTCAGCGGATGCTATCTGG
ATTTTTACACCAGTTTACAACCTCTCTATCCAGGTTCTGTTAAAAACCTGCTAGACTGGTTGTCTCGTGC
TCTTGATTTGTCTGATCCGACGGGCCATCTGCTATTGGCGGTAAGGTGGTTACGGTCTCTTCAGTTGCAA
ATGGCGGGCATGATCAAGTATTTGATCAGTTTAAAGCACTATTGCCGTTTATCCGAACCTCAGTAGCAGGA
GAGTTTACAAAAGCAACTGTGAATCCTGATGCTGGGGAACAGGAAGGCTTGAGATTTCAAAAAGAGACAAA
AGCAAACCTTGCTATCTCAGGCAGAGGCTCTTTTAGCGGCTATTTAG

SEQ ID NO: 84 amino acid sequence comprising GAS 511

MTDVSRIKLEARDQGRLLTLDYANLIFDDFMELHGDRHFSDDGAIVGGGLAYLAGQPVTVVIGIQKGNLQDN
LARNFGQPNPEGYRKALRLMKQAEKFRPVVTFINTAGAYPGVGAEEERGQGEAIKNNMEMSDLKVPPIAI
IIGEGSGGALALAVADQVWMLENTMYAVLSPEGFASILWKDGSRATEAAELMKITAGELYKMGIVDRIIP
EHGYFSSEIVDIIKANLIEQITSLQAKPLDQLLDERYQRFRKY

SEQ ID NO: 85 polynucleotide sequence encoding GAS 511

ATGACAGATGTATCAAGAAATTTAAAAGAAGCGCGTGATCAAGGGCGTTTAAACAACCTTGGATTACGCCAA
CCCTTATTTTCGATGACTTTATGGAACGTCATGGCGATCGCCATTTTTCAGATGATGGTGCCATTGTAGGTG
GCCTAGCTTATTTGGCGGGACAACCTGTTACGGTCATTGGTATTCAAAAAGGTAAGAAATTTACAGGATAAT
TTGGCAAGGAATTTTGGCCAGCCCAATCCAGAAGGTTATCGTAAAGCTTTGCGCCTTATGAAACAGGCAGA
AAAATTTGGACGACCAGTTGTTACGTTTATCAATACTGCAGGAGCCTATCCAGGTGTCGGTGCAGGAAGAAC
GAGGACAGGGTGAAGCCATTGCTAAAAATTTGATGGAAATGAGTGATCTCAAGGTTCCCATTTATCGCCATC
ATTATTGGTGAAGGAGGCTCTGGTGGTGCATTAGCCTTAGCGGTTGCCGATCAGGTCTGGATGCTTGAAA
TACTATGTATGCGGTTCTTAGCCCAGAAGGCTTTGCTTCTATTTTATGGAAGGATGGTTCAAGGGCGACCG
AGGCCGCTGAATTGATGAAAATCACAGCGGGTGAACCTACAAAATGGGAATAGTAGACCGTATTATTCCA
GAACATGGTTATTTTCAAGTGAATCGTTGACATCATCAAAGCTAACCTCATCGAACAATAACAGTATT
GCAAGCTAAGCCATTAGACCAATTATTAGATGAGCGCTACCAACGCTTTCGTAAATATTA

SEQ ID NO: 86 amino acid sequence comprising GAS 533

MAITVADIRREVKEKNVTFLLRMFTDIMGVMKNVEIPATKEQLDKVLSNKMVFDGSSIEGFVRINESDMYL
YPDLDTWIVFPWGDENGAVAGLICDIYTAEGKPFAGDPRGNLKRALKHMNEIGYKSFNLGPEPEFFLFKMD
DKGNPTELVNDNGGYFDLAPIDLADNTRREIVNILTGMGEVEASHHEVAVGQHEIDFKYADVLKACDNIQ
IFKLVVKTIAREHGLYATFMAKPKFGIAGSGMHCNMSLFDNQGNNAFYDEADKRGMQLSEDAYYFLGGLMK
HAYNYTAITNPTVNSYKRLVPGYEAPVYVAVAGSNRSPLIRVPASRGMGRLELRVSDPTANPYLALAVLL
EAGLDGIINKIEAPEPVEANIYTMTEERNEAGIIDLPSTLHNALKALQKDDVVQKALGYHIYTNFLEAKR
IEWSSYATFVSQWEIDHYIHNY

SEQ ID NO: 87 polynucleotide sequence encoding GAS 533

ATGGCAATAACAGTAGCTGACATTCGTGCTGAAGTCAAAGAAAAAATGTAACGTTTCTTCGCTTGATGTT
CACTGATATCATGGGCGTTATGAAAAATGTGGAGATTCCTGCAACTAAAGAACAGTTAGACAAAGTATTGT
CTAACAAGGTTATGTTTGGTTCATCTATCGAAGGTTTGTACGGATCAATGAGTCAGATATGTACCTT
TACCCCGATTTAGACACTTGGATTGTTTTCCCTGGGGAGATGAAAATGGAGCAGTTGCAGGTTAATTTG
TGATATTTATACAGCAGAAGGAAAGCCTTTTGCAGGAGATCCTAGAGGAAATTTAAAAGAGCCCTGAAAC
ACATGAACGAGATCGGCTACAAATCATTTAATCTTGGACCAGAACCAGAATTTTTCCTTTTAAAGATGGAT
GATAAAGGTAATCCGACACTTGAAGTTAAGATAATGGTGGTTATTTTGAATTTAGCGCAATTTGACTTAGC
AGACAACACGCGCCGTGAAATTTGTGAATTTTTAACGAAAATGGGTTTTGAAGTGAAGCTAGTCATCATG
AAGTGGCTGTTGGTCAACATGAGATTGATTTTAAATATGCAGATGTTTTGAAAGCTTGTGATAATATCAA
ATTTTTAAGCTAGTTGTA AAAACGATTGCCCGTGAACATGGACTTTATGCTACTTTCATGGCTAAACCAA
ATTTGGAATAGCTGGATCAGGGATGCACTGTAACATGCTTTTGTGATAACCAAGGTAATAATGCTTTTT
ATGATGAAGCTGATAAGCGAGGGATGCAGTTATCAGAAGATGCTTATTATTTCTTGGGAGGACTAATGAAG
CATGCTTATAACTACACTGCTATCACTAACCTACAGTGAATCTTATAAACGATTAGTTCAGGTTATGA

SEQUENCE LISTING

GGCACCTGTTTTATGTCGCTTGGGCTGGAAGTAATCGTTCACCGCTTATCCGTGTTCCAGCATCACGTGGTA
TGGGAACCGCTTTGGAGTTACGTTTCGGTTGATCCGACAGCTAATCCTTATTTAGCCTTGGCTGTTCTCTTG
GAAGCTGGATTAGATGGTATCATTAAACAAAATGGAAGCTCCAGAACCCGTTGAAGCTAACATTTATACCAT
GACAATGGAAGAACGAAATGAAGCAGGCATTATTGATTTGCCATCAACGCTTCATAATGCCTTAAAAAGCTC
TTCAAAAAGATGATGTGGTACAAAAGGCACTAGGTTACCATATCTACACTAATTTCTTAGAAGCAAAAACGA
ATTGAATGGTCTTCTATGCAACTTTTGTTCATGGAATTTGACCATTATATTCATAATTATTAG

SEQ ID NO: 88 amino acid sequence comprising GAS 527

MTEISILNDVQKIIVLDYGSQYNQLIARRIREFGVFSSELKSHKITAQELREINPIGIVLSGGPNSVYADNA
FGIDPEIFELGIPILGICYGMLITHKLGKVVPAQOAGNREYQSTLHLRETSKLFSGTPPEQLVLMESHG
DAVTEIPEGFHLVGDSDNCPYAAIENTEKNLYGIQFHPVRSVYGNLILKNFAISICGARGDWSMDNFIID
MEIAKIRETVDRKVLGLSGGVDSSVVGVLQKAIGDQLTCIFVDHGLLRKDEGDQVMGMLGGKFGFLNIID
RVDASKRFLDLLADVEDPEKRRKIIGNEFVYVFDDEASKLKGVDFLAQGTLYTDIIESGTEAQTIKSHHN
VGGLPEDMQFELIEPLNTLFKDEVRALGIALGMPEEIVWRQFPFPGPLAIRVMGAIITEEKLETVRESDAIIL
REEIAKAGLDRDVWQYFTVNTGVRVGVGMGDGRTYDYTIAIRAITSIDGMTADFAQLPWDVLKKISTRIVN
EVDHVNRIYVDITSKPPATVEWE

SEQ ID NO: 89 polynucleotide sequence encoding GAS 527

ATGACTGAAATTTCAATTTTGAATGATGTTCAAAAATTATCGTTCCTTGATTATGGTAGCCAGTACAATCA
GCTTATTGCTAGACGATTCGAGAGTTTGGTGTTCCTCCGAACATAAAAGCCATAAAATCACCGCTCAAG
AACTTCGTGAGATCAATCCCATAGGTATCGTTTTATCAGGAGGGCCAACTCTGTTTACGCTGATAACGCC
TTTGGCATTGACCCTGAAATCTTTGAAC TAGGGATTCCGATTCTTGGTATCTGTTACGGTATGCAATTAAT
CACCCATAAAATFAGGTGGTAAAGTTGTTCCGTGCTGGACAAGCTGGTAATCGTGAATACGGTCAGTCAACCC
TTCATCTTCGTGAAACGTCAAAATTTATTTTCAGGCACACCTCAAGAACAACCTCGTTTTGATGAGCCATGGT
GATGCTGTTACTGAAATTCAGAAAGTTTCCACCTTGTGGAGACTCAAATGACTGTCCCTATGCAGCTAT
TGAAAATACTGAGAAAACCTTTACGGTATTACAGTTCACCCAGAAGTGAGACACTCTGTTTATGGAAATG
ACATTCCTTAAAAACTTTGCTATATCAATTTGTGGCGCGCGTGGTGGTCAATGGATAATTTTATTGAC
ATGGAAATTGCTAAAATTCGTGAAACTGTAGGCGATCGTAAAGTTCTTCTAGGCTTTCTGGTGGAGTTGA
TCTTTCAGTTGTTGGTGTCTACTTCAAAAAGCTATCGGTGACCAATTAACCTGTATTTTCGTTGATCAG
GTTCTTTCGTAAGAGCAGGGCGATCAAGTTATGGGAATGCTTGGGGCAAATTTGGCCATAAATATTATC
CGTGTGGATGCTTCAAAACGTTTCTTAGACCTTCTTGCAGACGTTGAAGATCCTGAGAAAAACGTAATAAT
TATTGGTAATGAATTTGCTATGTTTTGATGATGAAGCCAGCAAATTA AAAAGGTGTTGACTTCCTTGCC
AAGGAACACTTTATACTGATATCATTTGAGTCAGGAACAGAACTGCTCAAACCATCAAATCACATCACAAT
GTGGGTGGTCTCCCCGAGACATGCAGTTTGAATTGATTGAGCCCTTAAACACTCTTTTCAAAGATGAAGT
TCGAGCGCTTGGAAATCGCTCTTGGAAATGCCTGAAGAAATTTGTTGGCGCCAACCATTTCCAGGTCTGGAC
TTGCTATCCGTGTCATGGGAGCAATTAAGTGAAGAAAACTTGA AACCGTTCGCGAATCAGACGCTATCCTT
CGTGAAGAAATGCTAAGGCTGGACTTGATCGTGACGTGTGGCAATACTTTACAGTTAACACAGGTGTCCG
TTCYTAGGCGTCACTGGGATGGTCTGATGATTATACCATCGCCATTCGTGCTATTACGCTATTG
ATGGTATGACAGCTGACTTTGCTCAACTTCTTGGGATGTCTTGA AAAAATCTCAACACGTTATCGTAAAT
GAAGTTGACCAGTTAACCCTATCGTCTACGACATCACAAGTAAACCACCCGCAACAGTTGAATGGGAATA
A

SEQ ID NO: 90 amino acid sequence comprising GAS 294

MSQSTATYINVIGAGLAGSEAYQIAKRGIPVKLYEMRGVKATPOHKTTNFELVCSNSFRGDSLTVAVGL
LKEEMRRLDSIIMRNGEANRVPAGGAMAVDREGYAESVTAELNHPLIEVIRGEITEIPDDAITVIATGPL
TSDALAEKIHALNGGDGFYFYDAAAPIIDKSTIDMSKVYLKSRDYDKGEAYLNC PMTKEEFMAFHEALTTA
BEAPLNAFEKEKYFEGCMPIEVMAKRGIKTMLYGPMPKPVGLEYPDDYTGPRDGEKTPYAVVQLRQDNAAG
SLYINVGFQTHLKWGEQKRVFQMI PGLENAEFVRYGVMRNSYMDSPNLLTETFQSRSPNPLFFAGQMTGV
EGYVESAAAGLVAGINAARLFKREELIFPQTTAIGSLPHYVTHADSKHFQPMNVNFGI I KELEGPRIRDK
KERYEAIASRALADLDTCLASL

SEQ ID NO: 91 polynucleotide sequence encoding GAS 294

TTGTC TCAATCAACTGCAACTTATATTAATGTTATTGGAGCTGGGCTAGCTGGTTC TGAAGCTGCCTATCA
GATTGCTAAGCGCGGTATCCCCGTTAAATTTGATGAAATGCGTGGTGTCAAAGCAACACCCGCAACATAAAA
CCACTAATTTTCCGAATTTGGTCTGTTCCAACCTCATTTCGTGGTGTAGCTTAACCAATGCAGTCCGCTTT
CTCAAAGAAGAAATGCGGCGATTAGACTCCATTATTATGCGTAATGGTGAAGCTAACC GCGTACCTGCTGG

SEQUENCE LISTING

GGGAGCAATGGCTGTTGACCGTGAGGGGTATGCAGAGAGTGTCACTGCAGAGTTGGAAAATCATCCTCTCA
 TTGAGGTCATTCGTGGTGAATTACAGAAATCCCTGACGATGCTATCACGGTTATCGCGACGGGACCGCTG
 ACTTCGGATGCCCTGGCAGAAAAAATTCACGCGCTAAATGGTGGCGACGGATTCTATTTTTACGATGCAGC
 AGCGCCTATCATTGATAAATCTACCATTGATATGAGCAAGGTTTACCTTAAATCTCGCTACGATAAAGGCG
 AAGCTGCTTACCTCAACTGCCCTATGACCAAAGAAGAATTCATGGCTTCCATGAAGCTCTGACAACCGCA
 GAAGAAGCCCCGCTGAATGCCCTTTGAAAAAGAAAAGTATTTGAAGGCTGTATGCCGATTGAAGTTATGGC
 TAAACGTGGCATTAAAACCATGCTTTATGGACCTATGAAACCCGTTGGATTGGAATATCCAGATGACTATA
 CAGGTCCTCGCGATGGAGAATTTAAAACGCCATATGCCGTCGTGCAATTGCGTCAAGATAATGCAGCTGGA
 AGCCTTTATAATATCGTTGGTTTCCAAACCCATCTCAAATGGGGTGAGCAAAAACGCGTTTCCAAATGAT
 TCCAGGGCTTGAANAATGCTGAGTTTGTCCGCTACGGCGTACATGCATCGCAATTCCTATATGGATTACCAA
 ATCTTTTAAACCGAAACCTTCCAATCTCGAGCAATCCAACCTTTTCCTTGCAGGTCAGATGACTGGAGTT
 GAAGGTTATGTCGAATCAGCTGCTTCAGGTTTAGTAGCAGGAATCAATGCTGCTCGTTTGTTCAAAAGAGA
 AGAAGCACTTATTTTTCTCAGACAACAGCTATTGGGAGTTGCCCTCATTATGTGACTCATGCCGACAGTA
 AGCATTTCACCAATGAACGTCAACTTTGGCATCATCAAAGAGTTAGAAGGCCACGCATTCGTGACAAA
 AAAGAAGCTTATGAAGCTATTGCTAGTCGTCTTTGGCAGATTAGACACCTGCTTAGCGTCGCTTAA

SEQ ID NO: 92 amino acid sequence comprising GAS 253

MPKKILFTGGGTVGHVTLNLILIPKFIKDGWEVHYIGDKNGIEHTEIEKSGLDVTFHAIATGKLRRYFSWQ
 NLADVFKVALGLLQSLFIVAKLRPQALF SKGGFVSVPPVVAAKLLGKPVFIHESDRSMGLANKIAYKFATT
 MYTTFEQEDQLSKVKHLGAVTKVFKDANQMPSTQLEAVKEYFSRDLKTLFLIGGSAGAHVFNQFISDHPE
 LKQRNYINITGDPHLNELSSHLYRVDYVTDLYQPLMAMADLVVTRGGSNLTFELLAMAKHLIVPLGKEA
 SRGDQLENATYFEKRGYAKQLQEPDLTLHNFQAMADLFEHQADYEATMLATKEIQSPDFYDLLRADISS
 AIKEK

SEQ ID NO: 93 polynucleotide sequence encoding GAS 253

ATGCCTAAGAAGATTTTATTTACAGGTGGTGGAACTGTAGGTCATGTCACCTTGAACCTCATTCTCATACC
 AAAATTTATCAAGGACGGTTGGGAAGTACATTATATTTGGTGATAAAAATGGCATTGAACATACAGAAATTG
 AAAAGTCAGGCCTTGACGTGACCTTTCATGCTATCGCGACAGGCAAGCTTAGACGCTATTTTTTCATGGCAA
 AATCTAGCTGATGTTTTAAGGTTGCACCTTGGCTCCTACAGTCTCTTTTATTGTTGCCAAGCTTCGCC
 TCAAGCCCTTTTTTCCAAAGGTGGTTTTGTCTCAGTACCAGGCTTGTGGCTGCTAAAATGCTTGGTAAAC
 CAGTCTTTTATTGATGAATCAGATCGGTCAATGGGACTAGCAAAACAAGATTGCCTACAAAATTTGCAACTACC
 ATGTATAACCACTTTTGAGCAGGAAGACCAGTTGCTAAAGTTAAACACCTTGGAGCGGTGACAAAGGTTTT
 CAAAGATGCCAACCAAAATGCCGTAATCAACTCAGTTAGAGCGGTGAAAGAGTATTTTAGTAGAGACCTAA
 AAACCCCTCTTGTATTATTTGGTGGTTTCGGCAGGGGCGCATGTGTTAATCAGTTTATAGTGATCATCCAGAA
 TTGAAGCAACGTTATAATATCATCAATATTACAGGAGACCTCACCTTAATGAATTGAGTTCATCTGTA
 TCGAGTAGATTATGTTACCGATCTTACCAACCTTTGATGGCGATGGCTGACCTTGTAGTGACAAGAGGGG
 GCTCTAATACACTTTTTGAGCTACTGGCAATTGGCTAAGCTACACCTCATCGTCTCTTTGGTAAAGAAGCT
 AGCCGTTGGCGATCAGTTAGAAAATGCCAATTTTTGGAGAAGAGGGGCTACGCTAAACAATTACAGGAACC
 TGATTTAACTTTGCATAAATTTGATCAGGCAATGGCTGATTTGTTTGAACATCAGGCTGATTATGAGGCTA
 CTATGTTGGCAACTAAGGAGATTCAGTCACCGACTTCTTTTATGACCTTTTGGAGAGCTGATATTAGCTCC
 GCGATTAAGGAGAAGTAA

SEQ ID NO: 94 amino acid sequence comprising GAS 529

MCGIVGVGNRNATDILMQGLEKLEYRGYDSAGIFVANANQTNLIKSVGRIADLRKIGIDVAGSTGIGHT
 RWATHGQSTEDNAHPHTSQTRFVLVHNGVIENYLHIKTEFLAGHDFKQTDTEIAVHLIGKFVEEDKLSV
 LEAFKKSLSIIEGSYAFALMDSQATDTIYVAKNKSPLLIIGLGEQYNMVCSAMAMIRETSEFMEIHDKELV
 ILTKDKVTVDYDGKELIRDSYTAELDLSDIGKGYPFYMLKEIDEQPTVMRQLISTYADETGNVQVDP
 AITSIQEADRLYILAAGTSYHAGFATKNMLEQLDTPVELGVASEWGYHMPPLSKKPMFILLQSGETADSR
 QVLVKANAMGIPSLFVTVNPGSTLSREATYMLIHAGPEIAVASTKAYTAQIAALAFKAVGEANGKQEA
 LDFNLVHELSLVAQSI EATLSEKDLVAEKVQALLATTRNAFYIGRNDYYVAMEAALKLKEISYIQCEGFA
 AGELKHGTISLIEEDTPVIALISSQLVASHTRGNIQEVAARGAHVLTVEEGLDREGDDIVNKVHPFLA
 PIAMVPTQLIAYYASLQRGLDVKPRNLAKAVTVE

SEQ ID NO: 95 polynucleotide sequence encoding GAS 529

ATGTGTGGAATTGTTGGAGTTGTTGGAAATCGCAATGCAACGGATATTTTAAATGCAAGGCCTTAAAAAGCT
 TGAATACCGGGTTATGATTACAGCAGGAATTTTGTGGCTAATGCCAATCAAACAACTTGATTAAATCAG

SEQUENCE LISTING

TGGGGCGGATTGCTGATTTGCGTGCCAAGATTGGCATTGATGTTGCTGGTTCAACAGGGATTGGTCACACC
 CGTTGGGCAACGCATGGCCAATCAACAGAGGATAATGCCCATCCTCACACGTCACAACTGGACGTTTTGT
 ACTTGTTCATAATGGTGTGATTGAAAATTACCTTCACATTAATAACAGAGTTCCTAGCTGGACATGATTTTA
 AGGGGCAGACAGATACTGAGATTGCAGTACACTTGATTGGAAAAATTTGTGGAAGAAGACAAGTTGTCAGTA
 CTGGAAGCTTTTAAAAAATCTTTAAGCATTATTTGAAGGTTCCCTACGCCTTTGCATTAATGGATAGCCAAGC
 AACTGATACTATTTATGTGGCTAAAAACAAGTCTCCATTGTTGATTGGACTTGGTGAAGGTTACAACATGG
 TTTGTTTCAGATGCCATGGCCATGATTTCGTGAAACCAGTGAATTTATGGAAATTCATGATAAGGAGCTAGTT
 ATTTTAAACCAAAGATAAGGTAAGTGTACAGACTACGATGGTAAAGAGCTGATACGAGATTCCCTACACTGC
 TGAATTAGACTTATCTGATATTGGCAAAGGGACTTATCCTTTCTATATGCTGAAAGAAATTTGATGAGCAAC
 CAACCGTAATGCGTCAATTAATTTCAACTTATGCAGATGAAACTGGTAACGTACAGGTTGATCCGGCTATC
 ATTACCTCTATCCAAGAGGCTGACCGTCTTTATATTTTAGCGGCAGGGACTTCTACCATGCTGGTTTTGC
 AACAAAAAATATGCTTGAGCAATTGACAGATAACCCAGTTGAGTTGAGTTGGGCGTGGCTTCTGAGTGGGGTTACC
 ACATGCCTCTGCTTAGCAAGAAAACCAATGTTTATCTACTAAGCCAATCAGGAGAAACCGCAGATAGTCGT
 CAAGTTTTAGTAAAGGCAAATGCTATGGGCATTCCGAGTTTGACAGTAACTAACGTTCCAGGATCAACCTT
 ATCACGTGAAGCAACATACACCATGTTGATTTCATGCTGGACCTGAAATTGCTGTTGCGTCTACAAAAGCTT
 ACACTGCACAAATGCTGCCCTTGCTTTTTGGCTAAGGCAGTTGGTGAGGCAAATGGTAAGCAAGAAGCT
 CTTGACTTTAACTGGTACATGAGTTGTCATTGGTTGCCCAATCTATTGAGGCGACTTTGCTGAAAAGA
 TCTCGTGGCAGAAAAGGTTCAAGCTTTGCTAGCTACTACTCGTAATGCTTTTTACATCGGGCGTGGCAATG
 ATTATTACGTTGCGATGGAAGCTGCTTTGAAATTAAGAGATTTCTTATATTCAATGCGAAGGCTTTGCG
 GCTGGTGAATGAAACATGGAACCATTTCAATTAATTGAGGAGGACACGCCAGTAATCGCTTAAATATCGTC
 TAGTCAGTTGTTGCTCTCATACGCGTGGTAATATTCAAGAAGTTGCTGCCCGTGGGGCTCATGTTTTAA
 CAGTTGTGGAAGAAGGGCTTGACCGTGAGGGAGATGACATTATTGTCAATAAGGTTTCATCCTTTCCCTAGCC
 CCGATTGCTATGGTCATTCCAACCACTGATTGCTTACTACGCTTCATTACAACGTGGACTTGATGTTGA
 TAAGCCACGTAATTTGGCTAAAGCTGTAACAGTAGAATAA

SEQ ID NO: 96 amino acid sequence comprising GAS 45

VTFMKKSKWLAAVSVALLSVSALAACGNKNASGGSEATKTYKYVFNPKSLDYILTNNGGTTDVTITQMV
 GLENDYGNLVP SLAKDWKVS KDGLTYTYTLR DGVSWYTA DGE EYAPVTAEDFVTGLKHA VDDKSDALYV
 VEDSIKNL KAYQNGE VDFKEVGVKALDDKT VQYTLNKPESYWN SKTYSV LFPVNAKFLKSKGDFGTTDP
 SSILVNGAYFLSAFTSKSMEFHKNENYWDAKNVGIESVKLTYSDGSDPGSFYKNFDKGEFSVARLYPNDP
 TYKSAKNYADNITYGMLTGD I RHLTWNLNRTSFKNTKKDPAQQDAGKKALNNKDFRQAIQFAFDRAFQA
 QTAGQDAKTALRNMLVPPFTFVTIGESDFGSEVEKEMAKLGDEWKDVNLADAQDGFYNPEKAKAEFAKAKE
 ALTAEGVTFPVQLDYPVDQANAATVQEAQSFQSV EASLGKENVIVNVLETETSTHEAQGFYAETPEQQDY
 DIISSWGPDPYQDPRTYLDIMSPVGGG SVIQKLG IKAGQNKDVVAAAGLDTYQTLLEAAA I TDDNDARYK
 AYAKAQAYLTDNAVDI PVVALGGT PRVTKAVPFSGGFSWAGSKGFLAYKGMKLDQKPVTVKQYEKAKKWM
 KAKAKSNAKYAEKLADHVEK

SEQ ID NO: 97 polynucleotide sequence encoding GAS 45

GTGACTTTTATGAAGAAAAGTAAATGGTTGGCAGCTGTAAGTGTTCGATCTTGTGATATCCGCTTTGGC
AGCTTGTGGTAATAAAAATGCTTCAGGTGGCTCAGAAGCTACAAAACCTACAAGTACGTTTTTGTAAACG
 ATCCAAAATCATTGGATTATATTTTACTAATGGCGGTGGAACGACTGATGTGATAACACAAATGGTTGAT
 GGTCTTTTGGAAAACGATGAGTATGGTAATTTAGTACCATCACTTGC TAAAGATTGGAAGGTTTCAAAGA
 CGGTCGACTTATACTTATACTCTTCGCGATGGTGTCTCTTGGTATACGGCTGATGGTGAAGAATATGCC
 CAGTAACAGCAGAAGATTTTGTGACTGGTTTGAAGCACGCGGTTGACGATAAATCAGATGCTCTTTACGTT
 GTTGAAGATTCAATAAAAACTTAAAGGCTTACCAAAAATGGTGAAGTAGATTTTAAAGAAGTTGGTGTCAA
 AGCCCTTGACGATAAACTGTTTCAGTATACTTTGAACAAGCCTGAAAGCTACTGGAATTCAAAAACA
 ATTAGTGTGCTTTTCCAGTTAATGCGAAATTTTGAAGTCAAAGGTAAAGATTTTGGTACAACCGATCCA
 TCATCAATCCTTGTTAATGGTGCTTACTTCTTGAGCGCCTTCACCTCAAATCATFCATGGAATTCATAA
 AATGAAAAC TACTGGGATGCTAAGAATGTTGGGATAGAATCTGTTAAATTGACTTACTCAGATGGTTTCA
 ACCAGGTTTCGTTCTACAAGAACTTTGACAAGGGTGAGTTCAGCGTTGCACGACTTTACCCAAATGACCC
 ACCTACAAATCAGCTAAGAAAAC TATGCTGATAACATTACTTACGGAATGTTGACTGGAGATATCCGTC
 TTTAACATGGAATTTGAACCGTACTTCTTTCAAACACTAAGAAAGACCCTGCACAACAAGATGCCGGTA
 AGAAAGCTTTAACAACAAGGATTTTCGTCAAGCTATTCAGTTTGC TTTTGACCGAGCGTCATTCCAAGCA
 CAACTGCAGGTCAAGATGCCAAAACAAAAGCCTTACGTAACATGCTTGTCCCACCAACATTTGTGACCAT
 TGGAGAAAGTGATTTTGGTT CAGAAGTTGAAAAGGAAATGGCAAACCTTGGTGTGATGAATGGAAGACGTTA
 ACTTAGCTGATGCTCAAGATGGTTCTATAATCCTGAAAAGCAAAGCTGAGTTTCAAAGCCAAAGAA

SEQUENCE LISTING

GCTTTAACAGCTGAAGGTGTAACCTTCCCAGTTCAATTAGATTACCCTGTTGACCAAGCAAACCGCAGCAAC
 TGTTTCAGGAAGCCAGTCTTTCAAACAATCTGTTGAAGCATCTCTTGGTAAAGAGAATGTCATTGTCAATG
 TTCTTGAAACAGAAACATCAACTCACGAAGCCCCAAGGCTTCTATGCTGAGACCCAGAACAACAAGACTAC
 GATATCATTTCATCATGGTGGGGACCAGACTATCAAGATCCACGGACCTACCTTGACATCATGAGTCCAGT
 AGGTGGTGGATCTGTTATCCAAAACTTGAATCAAAGCAGGTCAAATAAGGATGTTGTGGCAGCTGCAG
 GCCTTGATACCTACCAAACCTTCTTGATGAAGCAGCAGCAATTACAGACGACAACGATGCGCGCTATAAA
 GCTTACGCAAAGCACAAGCCTACCTTACAGATAATGCCGTAGATATCCAGTTGTGGCATTGGGTGGCAC
 TCCACGAGTTACTAAAGCCGTTCCATTTAGCGGGGGCTTCTCTTGGGCAGGGTCTAAAGGTCCTCTAGCAT
 ATAAAGGAATGAACTTCAAGACAAACCTGTCACAGTAAACAATACGAAAAGCAAAGAAAATGGATG
 AAAGCAAAGGCTAAGTCAAATGCAAAATATGCTGAGAAGTTAGCTGATCACGTTGAAAA

SEQ ID NO: 98 amino acid sequence comprising an N-terminal leader sequence of GAS 45
 VTFMKKSKWLAAVSVAILSVSALAA

SEQ ID NO: 99 amino acid sequence comprising a fragment of GAS 45 where the N-terminal
 leader sequence is removed

CGNKNASGGSEATKTYKYVFNDFPKSLDYILTNNGGTTDVI TQMVDGLENDEYGNLVP SLAKDWKVSKDG
 LTYTYTLRDGVSWYADGEEYAPVTAEDFVTLKHA VDDKSDALYVVEDSIK NLKAYQNGEVDFKEVGVKA
 LDDKTVQYTLNKPESYWNKTTY SVLFPVNAKFLKSKGKDFGTTDPSSILVNGAYFLSAFTSKSSMEFHK
 ENYWDKAVNGIESVKLTYSDGSDPFSFYKNFDKGEFSVARLYPNDP TYKSARKNYADNITYGMLTGD
 IRHL TWNLNRTSFKNTKKDPAQQDAGKKALNNDFRQAIQFAFDRASFQAQTAGQDAKTALRNMLVPP
 FTVTIG ESDFGSEVEKEMAKLGD EWKDVNLADAQDGFYNPEKAKAEFAKAKEALTAEGVTFPVQLDY
 PVDQANAATV QEAQSFKQSV EASLGKENVIVNVLETETSTHEAQGFYAETPEQQDYDISSWWGPDY
 QDPRTYLDIMSPVG GGSVIQKLG IKAGQNKDVVAAAGLDTYQTLLEAAAITDDNDARYKAYAKA
 QAYLTDNAVDIPVVALGGTF RVTKAVPFGGFSWAGSKGPLAYKGMKLDQKPVTVKQYEKAKEK
 WMKAKAKSNAKYAEKLADHVEK

SEQ ID NO: 100 amino acid sequence comprising GAS 95

MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTFSTGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGS
 SERASKWEGNSDSMILVTVPNPKTKKTTMTSLERD LTTLSGPKNNEMNGVEAKLNAAYAAGGAQMAIMTVQ
 DLLNITIDNYVQINMQGLIDL VNAVGGITVTNEFDFPISIAENEPEYQATVAPGTHKINGEQALVYARMRY
 DDPEDYGRQKRQREVIQKVLKILALDSISSYRILSAVSSNMQTNIEISSRTIPSL LGYRDALRTIKTY
 QLKGEDATLSDGGSYQIVTSNHLLEIQNRIRTELGLHKVNQLKTNATVYENLYGSTKSTQVNMNYDSSGQA
 PSYSDSHSSYANYSSGVDTGQSASTDQDSTASSHRPATPSSSSDALADESSSSGSGSLVPPANINPQT

SEQ ID NO: 101 polynucleotide sequence encoding GAS 95

ATGAAAATTGGAAAAAATAGTTTAAATGTTACAGCTATTGTGTTAACAAC TGTCTTGGCATTAGGTGT
CTATCTAACTAGTGCTTATACTTCTCAACAGGAGAATTA TCAAAGACCTTTAAAGATTTTCGACATCTT
 CAAACAAAAGTGATGCCATTAAACAAAACAAGAGCTTTTCTATCTTGTGATGGGTGTTGATACAGGCTCT
 TCAGAGCGTGCCCTCAAGTGGGAAGGAAACAGTGATTCGATGATTTTGGTTACGGTTAATCAAAGACCAA
 GAAAACAACATGACTAGTTTAGAACGAGATACCTTAACCACGTTATCTGGACCCAAAATAATGAAATGA
 ATGGTGTGTAAGCTAAGCTTAACGCTGCTTATGCAGCAGGTGGCGCTCAGATGGCTATTATGACCGTGCAA
 GATCTTTTGAATATCACCATTGATAACTATGTTCAAATTAATATGCAAGGCCTTATTGATCTTGTGAATGC
 AGTTGGAGGGATTACAGTTACAAATGAGTTTGATTTTCTATCTCGATTGCTGAAAACGAACCTGAATATC
 AAGCTACTGTTGCGCCTGGAACACACAAAATTAACGGTGAACAAGCTTTGGTTTATGCTCGTATGCGTTAT
 GATGATCCTGAGGGAGATTATGGTCGACAAAAGCGTCAACGTGAAGTCATTCAAAGGTATTGAAAAAAT
 CCTTGCCTTGATAGCATTAGCTCTTATCGGAAGATTTTATCTGCTGTAAGTAGTAATATGCAAACGAATA
 TCGAAATCTCTTCGCACTATCCCTAGTCTATTAGGTTATCGTGACGCACCTTAGAATATTAAGACTTAT
 CAACTAAAAGGAGAAGATGCCACTTTATCAGATGGTGGATCATAACCAATTGTTACCTCTAATCATTTGTT
 AGAAATCCAAAATCGTATCCGAACAGAATTAGGACTCATAAGGTTAATCAATTA AAAACAATGCTACTG
 TTTATGAAAATTTGTATGGGTCAACTAAGTCTCAGACAGTAAACAACAAC TATGACTCTTCAGGCTAGGCT
 CCATCTTATCTGATAGTCATAGCTCTTACGCTAATTAATCAAGTGGAGTAGATACCGCCAGAGTGCTAG
 TACAGACCAGGACTCTACTGCTTCAAGCCATAGGCCAGTACGCCGCTCTCTTCATCAGATGCTTTAGCAG
 CTGATGAGTCTAGCTCATCAGGGTCTGGATCATTAGTTCTCTCTGCTAATATCAACCCTCAGACCTAA

SEQ ID NO: 102 amino acid sequence comprising N-terminal leader sequence of GAS 95
 MKIGKKIVLMFTAIVLTTVLALGVYLTSAYTFS

SEQUENCE LISTING

SEQ ID NO: 103 amino acid sequence comprising a fragment of GAS 95 where the N-terminal leader sequence is removed.

TGELSKTFKDFSTSSNKSDAIKQTRAFSILLMGVDTGSSERASKWEGNSDSMILVTNPKTKKTTMTSLER
 DTLTTLSPKKNEMNGVEAKLNAAYAAGGAQMAIMTVQDLLNITIDNYVQINMQGLIDLVNAVGGITVTNE
 PDPFISIAENEPEYQATVAPGTHKINGEQALVYARMRYDDPEGDYGRQKRQREVIQVKLKKILALDSISSY
 RKILSAVSSNMQTNIEISSRTIPSLLLGYRDALRTIKTYQLKGEDATLSDGGSYQIVTSHLLEIQNRIRTE
 LGLHKVNQLKTNATVYENLYGSTKSTQTVNNNYDSSGQAPSYSDSHSSYANYSSGVDTGQSASTDQDSTASS
 HRPATPSSSSDALADESSSSGSGSLVPPANINPQT

SEQ ID NO: 104 amino acid sequence comprising GAS 193

MKKRKLAVTLLSTILLNSAVPLVVADTSLRNSTSSDTQPTTADTDTDESETPKKDKKSKETASQHDQK
 DHKPSHTHTPPSNDTKQTDQASSEATDKPNKDKNDTKQPDSSDQSTPSPKDQSSQKESQNKDGRPTSPD
 QQKDQTPDKTPEKSADKTPEKGPEKATDKTPEPNRDAPKPIQPPLAAAPVFI PWRESKDLSKLPSSRSS
 AAYVRHWGTDSAYTHNLLSRRYGITAEQLDGFNLNLSLGIHYDKERLNGKRLLLEWEKLTGLDVRAIVAIAEAE
 SSLGTQGVAKKEGANMFGYGAFDFNPNNAKYSDEVAIRHMVEDTIIANKNQTFERQDLKAKKWSLQGLDT
 LIDGGVYFTDTSGSGQRRADIMTKLDQWIDDHGSTPEIPEHLKITSQTQFSEVPVGYKRSQPQNVLTYSKSE
 TYSFGQCTWYAYNRVKELGYQVDRYMGNGGDWQRKPGFVTHKPKVGYVVSFAPGQAGADATYGHVAVVEQ
 IKEDGSILISESNVMGLGTISYRTFTAEQASLLTYVVGDKLPRP

SEQ ID NO: 105 polynucleotide sequence encoding GAS 193

ATGAAGAAAAGGAAAATTGTTAGCAGTAACACTATTAAGTACCATACTCTTAAACAGTGCAGTGCCATTAGT
 TGTGTGCTGATACCTCCTTGC GTAATAGCACATCATCCACTGATCAGCCTACTACAGCAGATACTGATACGG
 ATGACGAGAGTGAAACACCAAAAAAGACAAAAAAGCAAGGAAACAGCGTCGCAGCAGCAGACCCAAAAA
 GACCATAAGCCATCACACACTCACCAACCCCCCTTCAAATGATAC TAAGCAGACCGATCAGGCATCATC
 TGAAGCTACTGACAAACCAAATAAAGACAAAAACGACACCAAGCAACCAGACAGCAGTGATCAATCCACCC
 CATCTCCCAAAGACCAGTCGTCTCAAAAAGAGTCAAAAACAAAGACGGCCGACC TACCCCATCACCTGAT
 CAGCAAAAAGATCAGACACCTGATAAAACACCAGAAAAATCAGCTGATAAAACCCCTGAAAAAGGACCAGA
 AAAAGCAACTGATAAAAACACCAGAGCCAAATCGTGACGCTCCAAAACCCATCCAACCTCCTTTAGCAGCTG
 CTCCTGCTTTTATACCTTGGAGAGAAAGTGACAAAGACTGAGCAAGCTAAAACCAAGCAGTCGCTCATCA
 GCGGCTTACGTGAGACACTGGACAGGTGACTCTGCCTACACTCACACCTGTTGTCACGCCGTTATGGGAT
 TACTGCTGAACAGCTAGATGGTTTTTTGAAACAGCTAGGTATTCACTATGATAAAGAACGCTTAAACGGAA
 AGCGTTTTATTAGAATGGGAAAAACTAACAGGACTAGACGTTTCGAGCTATCGTAGCTATTGCAATGGCAGAA
 AGCTCACTAGGTACTCAGGGAGTTGCTAAAGAAAAAGGAGCCAATATGTTTGGTTATGGCGCCTTTGACTT
 CAACCCAAACAAATGCCAAAAAATACAGCGATGAGGTTGCTATTCGTCACATGGTAGAAGACACCATCATTG
 CCAACAAAACCAAACCTTTGAAAGACAAGACCTCAAAGCAAAAAAATGGTCACTAGGCCAGTTGGATACC
 TTGATTGATGGTGGGGTTTTACTTTACAGATAACAAGTGGCAGTGGGCAAAGACGAGCAGATATCATGACCAA
 ACTAGACCAATGGATAGATGATCATGGAAGACACCTGAGATTCCAGAACATCTCAAGATAACTTCCGGGA
 CACAATTTAGCGAAGTGCCCGTAGGTTATAAAAAGAAAGTCAGCCACAAAACGTTTTTGACCTACAAGTCAGAG
 ACCTACAGCTTTGGCCAATGCAC TTGGTACGCCATAAATCGTGTCAAAGAGCTAGGTTATCAAGTCGACAG
 GTACATGGGTAACGGTGGCGACTGGCAGCGCAAGCCAGGTTTTGTGACCACCCATAAACCTAAAGTGGGCT
 ATGTCGCTCATTTGCACCAGGCCAAGCAGGAGCAGATGCAACCTATGGTCACGTTGCTGTTGTAGAGCAA
 ATCAAAGAAGATGGTTCATCTTAATTTAGAGTCAAATGTTATGGGACTAGGCACCATTTCCATATCGGAC
 GTTCACAGCTGAGCAGGCTAGTTTTGTTGACCTATGTCTAGGGGACAACTCCCAAGACCATAA

SEQ ID NO: 106 amino acid sequence comprising GAS 137

MSDKHINLVIVTGMMSGAGKTVAIQSFEDLGYFTIDNMPALVPKFLELIEQTNENRRRVALVDMRSRLFFK
 EINSTLDSIESNPSIDFRILFLDATDGELVSRYKETRRSHPLAADGRVLDGIRLERELLSPLKSMSQHVV
 TTKLTPRQLRKTISDQFSEGSNQASFRIEVMSFGFKYGLPLDADLVFDVRFPLPNPYQVELREKTGLDEDV
 FNYVMSPHESEVFYKHLNLLIVPILPAYQKEGKSVLTVAI GCTGGQHRSVAFHCLAESLATDWSVNESH
 DQNRKRVNRS

SEQ ID NO: 107 polynucleotide sequence encoding GAS 137

ATGTCAGACAAACACATTAATTTAGTTATTGTGACAGGAATGAGCGGCGCTGGAAAAACAGTTGCCATTCA
 GTCCTTTGAGGATCTAGGCTACTTTACCATTGATAAATATGCCCCACGCTTGGTTCCAAAATTTTTAGAAT
 TAATTGAAACAAACCAATGAAAATCGTAGGGTGGCTTTGGTTGTCGATATGAGAAGTCGTTTTGTTTTCAAG

SEQUENCE LISTING

GAAATTAATCTACCTTAGATAGTATTGAAAGCAATCCTAGCATTGATTTTCGGATTCTTTTTTTGGATGC
AACGGATGGAGAATTGGTGTACACGCTATAAAGAAACCAGACGGAGCCACCCTTGGCTGCGGACGGTCGTG
TGCTTGATGGTATTTCGATTGGAAAGAGAACTCTATCTCCTTTGAAAAGCATGAGCCAACATGTGGTGGAT
ACAACAAAATTGACCCTAGACAATTGCGTAAAACCAATTCAGACCAGTTTTCTGAAGGGTCAATCAAGC
CTCTTTCCGTATTGAAGTGATGAGCTTTGGGTTCAAATATGGTCTTCCTTTGGATGCGGATTTGGTTTTTG
ATGTGCGTTTTCTACCCAATCCTTATTATCAGGTAGAGCTTCGTGAAAAAACAGGACTAGATGAGGACGTT
TTTAATTATGTGATGTCTCACCCAGAATCAGAGGTGTTTTACAAGCATTGTTAAACCTTATGTCCCTAT
CTTACCGCTTACAAAAAGAAGGAAGTCTGTCTTGACGGTGGCTATTGGCTGCACAGGAGGCCAACACC
GCAGCGTTGCCTTTGCCATTGCTTGGCAGAAAGTCTGGCAACAGATTGGTTCGGTTAATGAAAGCCATCGT
GATCAAAATCGTCGTAAGGAAACGGTGAATCGTTCATGA

SEQ ID NO: 108 amino acid sequence comprising GAS 84

MIKKRTVAILAIASSFFLVACQATKSLKSGDANGVYQKQKSITVGFNTFVPMGYKDESGRCKGFDIDL
KEVFHQYGLKVNQAINWDMKEAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIVVKRSDIKTI
SDMKHKVLGAQSASSGYDSLRLTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVIANYLAK
QLENYRMIPTTFENEAF SVGLRKEDKTLQAKINRAFRVLYQNGKFOAISEKWFGDDVATANIKS

SEQ ID NO: 109 polynucleotide sequence encoding GAS 84

ATGATTATAAAAAAAGAACCGTAGCAATTTTAGCCATAGCTAGTAGCTTTTTCTTGGTAGCTTGTC AAGC
TACTAAAAGTCTTAAATCAGGAGATGCTTGGGGAGTTTACCAAAGCAAAAAGTATTACAGTTGGTTTTG
ACAATACGTTTGTTCCTATGGGCTATAAGGATGAAAGCGGCAGATGCAAAGGTTTGTATTTGATTTGGCT
AAAGAAGTTTTTCACCAATATGGACTCAAGGTTAACTTTCAAGCTATTAATTGGGACATGAAAGAAGCAGA
ACTAAACAATGGTAAAATTGATGTAATCTGGAATGGTTATTCAATAACTAAGGAGCGTCAGGATAAGGTTG
CCTTTACTGATTCTTACATGAGAAATGAACAAATTATTGTTGTCAAAAAAGATCTGATATTAACAATA
TCAGATATGAAACATAAAGTGTTAGGAGCACAAATCAGCTTCATCAGGTTATGACTCCTTGTTAAGAACTCC
TAAACTGCTGAAAGATTTTATTAATAAATAAAGACGCTAATCAATATGAAACCTTTACACAAGCTTTTTATTG
ATTTAAAATCAGATCGTATCGATGGAATATTGATTGACAAAGTATATGCCAATFACTATTTAGCAAAAGAA
GGGCAATTAGAGAATTATCGGATGATCCAACGACCTTTGAAAATGAAGCATTFTTCGGTTGGACTTAGAAA
AGAAGACAAAACGTTGCAAGCAAAAATTAATCGTGCTTTTCAAGGTTGCTTTATCAAAATGGCAAAATTTCAAG
CTATTTCTGAGAAATGGTTTGGAGATGATGTTGCCACTGCCAATATTAATCTTAA

SEQ ID NO: 110 amino acid sequence comprising N-terminal leader sequence of GAS 84

MIKKRTVAILAIASSFFLVA

SEQ ID NO: 111 amino acid sequence comprising a fragment of GAS 84 where the N-terminal leader sequence is removed

CQATKSLKSGDANGVYQKQKSITVGFNTFVPMGYKDESGRCKGFDIDLAKEVFHQYGLKVNQAINWDMK
EAELNNGKIDVIWNGYSITKERQDKVAFTDSYMRNEQIIVVKRSDIKTISDMKHKVLGAQSASSGYDSL
RTPKLLKDFIKNKDANQYETFTQAFIDLKSDRIDGILIDKVIANYLAKQLENYRMIPTTFENEAF SVG
LRKEDKTLQAKINRAFRVLYQNGKFOAISEKWFGDDVATANIKS

SEQ ID NO: 112 amino acid sequence comprising GAS 384

MKTLAFDTSNKTLSLAILDDETLADMTLNIQKKHSVSLMPAIDFLMTCDDLKPDLERIVVAKGPGSYTG
LRVAVATAKTLAYSLNIALVGISSLYALAASTCKQYPNTLVVPLIDARRONAYVGYRQKSVMPQAHASL
EVIIEQLVEEQQLIFVGETAPFAEKIQKLPQAILLPTLPSAYECGLLGQSLAPENVDAFVPOYLKRVEAE
ENWLKDNEIKDSSHVVKRI

SEQ ID NO: 113 polynucleotide sequence encoding GAS 384

ATGAAGACACTTGCATTTGATACCTCAAATAAAACCTTGTCCTTGCCTATACTTGATGATGAGACACTTCT
AGCAGATATGACCCTTAACATTCAGAAAAACATAGTGTAGCCTTATGCCTGCTATTGATTTTTGATGA
CTTGTACTGATCTTAAACCTCAAGATTTAGAAAGAAATAGTGGTTGCAAAGGCCCTGGATCTTACACAGGT
TTACGAGTGGCAGTTGCTACTGCAAAAACGTTAGCGTACAGTTTAAATATTGCATTGGTTCGGGATTTTCGAG
TCTATATGCTTTGGCTGCGTCTACTTGTAAACAGTATCCAATACTTTGGTGGTGCCATTGATTGATGCTA
GAAGGCAAAATGCGTATGTAGGTTATTATCGGCAAGGAAATCAGTGATGCCACAAGCCATGCTTCACTA
GAAGTTATTATAGAACAATTAGTAGAAGAAGGACAGCTGATTTTTGTTGGGGAGACTGCTCCTTTTGTGTA

SEQUENCE LISTING

GAAAATTCAAAGAAACTACCTCAGGCGATACTACTTCCAACCCCTCCTTCTGCTTACGAATGTGGTCTTTT
TGGGGCAAAGTTTGGCACCAGAAAATGTAGACGCCTTTGTCCCTCAATATCTCAAGAGAGTGGAAGCTGAA
GAAACTGGCTCAAAGATAATGAGATAAAAAGTAGATAGTCACTACGTTAAGCGAATCTAA

SEQ ID NO: 114 amino acid sequence comprising GAS 202

MLKRLWLILGPLLIAFVLVVITIFSFPTQLDHSIAQEKANAVAITDSSFKNGLIKRQALSDETCRFVPPFFG
SSEWSRMDSMHPSVLAERYKRSYRPFLLIGKRGSASLSHYGIQQITNEMQKKKAI FVVSPQWFTAQGINPS
AVQMYLSNTQVIEFLKARTDKESQFAAKRLELNPVSKSNLLKKVSKGKSLSRDLRAILKQHQVALRE
ESLFSFLGKSTNYEKRILPRVKGLPKVFSYKQLNALATKRGQLATTNNRFGIKNTFYRKRIAPKYNLYKNF
QVNYSYLASPEYNDFQLLLSEFAKRKTDVLFVITPVNKAWADYTGLENQDKYQAAVRKIKFQLKSQGFHRIA
DFSKDGGESYFMQDTIHLGWNGWLAFDKKVQPFLETQKQVFNPKMNPYFYFSKIWANRKLQ

SEQ ID NO: 115 polynucleotide sequence encoding GAS 202

ATGCTTAAGAGACTCTGGTTAATTC TAGGTCCTCTTCTTATTGCCTTTGTTTTAGTAGTACTACTATTTT
TAGTTTTCTACACAACTTGATCATTCCATAGCTCAGGAAAAGCAAATGCCGTTGCGATCACAGATAGTT
CTTTTAAAAATGGTTTGATTAAGACAAGC TTTATCAGATGAGACTTGTCGTTTTGTGCCTTTTTTTGGT
TCTAGCGAATGGAGTCGAATGGATAGTATGCACCCTTCGGTGCTGCAGAGCGCTACAAGCGGAGCTATAG
ACCATTTTAAATTGGTAAGAGAGGATCAGCATCTTTGTGCGATTATTATGGTATAACAACAAATTACCAATG
AAATGCAAAAAGAAAAAGCCATCTTTGTAGTATCTCCTCAATGGTTTACTGCTCAAGGGGATTAATCCTAGT
CCGGTTTCAGATGTACTGTCTAACACTCAAGTGATTGAATTTTACTAAAAGCTAGAACTGATAAAGAATC
ACAGTTTGCAGCAACCGTTGCTTGAGCTTAACCC TGGTGTCTAAACTCAAACCTTATTGAAAAAGTAA
GTAAGGGTAAGTCTCTTAGTCGGTTAGACAGAGCTATTTTGAATGTCAACATCAAGTAGCATGAGAGAA
GAGTCCCTTTTTAGTTTTTTAGGCAAATCTACTAAC TATGAAAAAGAATTTTGCTCGCGTTAAGGGATT
ACCTAAAGTATTTTCGTATAAACAATTGAATGCATTAGCAACTAAGAGAGGCCAATTAGCAACAACCAACA
ACCGTTTTGGGATTA AAAATACATTTTATCGTAAACGAATAGCACCTAAATACAATCTTTATAAGAATTC
CAAGTTAATTATAGTTACCTGGCGTCACCAGAATACAATGATTTT CAGCTTTTATTATCAGAATTTGCTAA
ACGAAAAACAGATGTACTCTTTGTTATAACTCCTGTTAATAAAGCTTGGGCGGATTATACCGGCTTAAATC
AAGATAAGTATCAAGCGGCAGTTCGTAAAATAAAATCCAGTTAAAGTCACAAGGATTTTCATCGCATTGCT
GACTTCTCAAAGATGGTGGTGAAGTCTACTTTATGCAAGTATACCATCCATCTCGGTTGGAATGGCTGGTT
AGCTTTTGATAAGAAAGTCAACCATTTCTAGAAACGAAGCAGCCAGTGCCCAACTATAAAATGAACCTT
ATTTTTATAGTAAAATTTGGGCAAATAGGAAAGACTTGAATAG

SEQ ID NO: 116 amino acid sequence comprising GAS 057

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVAADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQDT
SQITLKTNREKEQSQDLVSEPTTELDTDAA SMANTGSDATQKSASLPPVNTDVHWDVWVKRGAWDKGYKG
QGKVVAVIDTGIDPAHQSMRISDVSTAKVSKEDMLARQKAAGINYG SWINDKVVF AHNYVENSNDNIKENQ
FEDFDEDWENFEFDAEAEPKAIKKHKIYR PQSTQAPKETVIKTEETDGS HDIDWTQTD DDTKYESHGMHVT
GIVAGNSKEAAATGERFLGIAPEAQVMFMRVFANDIMGSAESLF IKAIEDAVALGADV INLSLGTANGAQL
SGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS DHDDPLATNPDYGLVGS PSTGRTPTSVAAINSKWVIQRL
MTVKELENRADLNHGKAIYSESVDFKDIKDSLGYDKSHQFAYVKEST DAGYNAQDVKGKIALIERDPNKTY
DEMIALAKKHGALGVLI FNPKPGQSNRSMRLTANGMGI PSAFISHEFGKAMS QLNNGTGSLEFDSVVS KA
PSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGASLLVKQYLEKTQP
NLPKEKIADIVKNLLMSNAQIHVNPETKTTTSPRQQAGLLNIDGAVT SGLYVTGKDNYSISLGNITDTM
TFDVTVHNL SNKDKTLRYDTELLTDHVPQKGRFTL TSHSLKTYQGGEVTV PANGKVTVRVTM DVSQFTKE
LTKQMPNGYYLEGFVRF RDSQDDQLNRVNI PFVGFKGQFENLAVAEES IYRLKSQGKTGFYFDES GPKDDI
YVGKHFTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAPKGV
FLRKYQGLKASVYHASDKEHKNPLWVSPESFKGDKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHY
VVSYYPDVVGAKRQEMTFDMILDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDSVFYLERKDNKPYT
VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFFYMVEDFAGNVAIAKLG DHPQLGKTPIKLK
LTDGNYQTKETLKNLEMTQSDTGLVTNQAQLAVVHRNQFQS QLTKNMQDFFISPNE DGNKDFVAFKGLKN
NVYNDLTVNVYAKDDHQKQTP IWSQAGASVSAIESTAWYGITARGSKVMPGDYQYVVTYRDEHGKEHQKQ
YTI SVNDKKPMITQGRFD TINGVDHF TPDKTKALDSSGIVREEVFY LAKKNGRKF DVTEGKDGITVSDNKV
YI PKNPDGSYTISKRDGVTLS DYYYLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDL PVPEDKQIVNFYI
LVRDADGKPIENLEYYNNSGNSLILPYGKYTVELLTYDTNAAKLES DKIVSFTLSADNNFQQVTFKIMTLA
TSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQSLYVPKAYGKTVQEGTYEVVVS LPKGYRIEGNTKVNTLP

SEQUENCE LISTING

NEVHEL^SLR^LVK^VGD^SAD^STGD^HK^VMS^KNN^SQ^AL^TAS^AT^PTK^STT^SA^TA^KAL^PST^GE^KM^LK^LR^IV^LGL^LL^L
GL^TCV^FSR^KK^STK^D

SEQ ID NO: 117 polynucleotide sequence encoding GAS 057

GTGGAGAAAAAGCAACGTTTTTCCCTTAGAAAATACAAATCAGGAACGTTTTTCGGTCTTAATAGGAAGCGT
TTTCTTGGTGTAGACAACAACAGTAGCAGCAGATGAGCTAAGCACAATGAGCGAACCAACAATCACGAATC
ACGCTCAACAACAAGCGCAACATCTCACC AATACAGAGTTGAGCTCAGCTGAATCAAATCTCAAGACACA
TCACAAATCACCTCAAGACAAATCGTGA AAAAGAGCAATCACAAGATCTAGTCTCTGAGCCAACCACAAC
TGAGCTAGCTGACACAGATGCAGCATCAATGGCTAATACAGGTTCTGATGCGACTCAAAAAGCGCTTCTT
TACCGCCAGTCAATACAGATGTTACGATTTGGGTAAAACCAAAGGAGCTTGGGACAAGGGATACAAAGGA
CAAGGCAAGGTTGTGCGAGTTATTGACACAGGGATCGATCCGGCCATCAAAGCATGCGCATCAGTGATGT
ATCAACTGCTAAAGTAAAATCAAAGAAGACATGCTAGCAGCCAAAAGCCGCCGGTATTAATTATGGGA
GTTGGATAAATGATAAAGTTGTTTTGACACATAAATTATGTGAAAATAGCGATAATATCAAAGAAAATCAA
TTGAGAGATTTTGATGAGGACTGGGAAAACTTTGAGTTTGATGCAGAGGCAGAGCCAAAAGCCATCAAAA
ACACAAGATCTATCGTCCCAATCAACCCAGGCACCGAAAAGAACTGTTATCAAAACAGAAGAAACAGATG
GTTACATGATATTGACTGGACACAACAGACGATGACACCAAATACGAGTCACACGGTATGCATGTGACA
GGTATTGTAGCCGGTAATAGCAAAGAAGCCGCTGCTACTGGAGAACGCTTTTTAGGAATTGCACCAGAGGC
CCAAGTCATGTTTATGCGTGTTTTTGCCAACGACATCATGGGATCAGCTGAATCACTCTTTTATCAAAGCTA
TCGAAGATGCCGTGGCTTTAGGAGCAGATGTGATCAACCTGAGTCTTGGAAACCGCTAATGGGGCACAGCTT
AGTGGCAGCAAGCTCTAATGGAAGCAATGAAAAGCTAAAAAGCCGGTGTATCAGTTGTTGTAGCAGC
AGGAAATGAGCGCGCTATGATGCTGACCATGATGATGATTTGGCGACAAAATCCAGACTATGGTTTGGTCG
GTTCTCCCTCAACAGGTCGAACACCAACATCAGTGGCAGCTATAAACAGTAAGTGGGTGATTCAACGCTTA
ATGACGGTCAAAGAATTAGAAAACCGTGCCGATTTAAACCATGGTAAAGCCATCTATTCAGAGTCTGTGCA
CTTTAAAGACATAAAAGATAGCCTAGGTTATGATAAATCGCATCAATTTGCTTATGTCAAAGAGTCAACTG
ATGCGGGTTATAACGCACAAGACGTTAAAGGTAAAATTGCTTTAATTGAACGTGATCCCAATAAAACCTAT
GACGAAATGATTGCTTTGGCTAAGAAACATGGAGCTCTGGGAGTACTTATTTTTAATAACAAGCCTGGTCA
ATCAAACCGCTCAATGCGTCTAACAGCTAATGGGATGGGGATACCATCTGCTTTCATATCGCACGAATTTG
GTAAGGCCAATGCTCCAATTAATGGCAATGGTACAGGAAGTTTAGAGTTTGACAGTGTGGTCTCAAAGCA
CCGAGTCAAAAAGGCAATGAAATGAATCAATTTTCAAATTTGGGGCTAACTTCTGATGGCTATTTAAAACCC
TGACATTACTGCACCAGGTGGCGATATCTATTCTACCTATAACGATAACCACTATGGTAGCCAAAACAGGAA
CAAGTATGGCCCTCTCTCAGATTGCTGGCGCCAGCCTTTTGGTCAAACAATACCTAGAAAAGACTCAGCCA
AACTTGCCAAAAGAAAAAATTGCTGATATCGTTAAGAACCTATTGATGAGCAATGCTCAAATTCATGTTAA
TCCAGAGACAAAACGACCACCTCACCGCTCAGCAAGGGGCAGGATTACTTAATATTGACGGAGCTGTCA
CTAGCGGCCTTTATGTGACAGGAAAAGACAACATATGGCAGTATATCATTAGGCAACATCACAGATACGATG
ACGTTTGATGTGACTGTTCAACAACCTAAGCAATAAAGACAAAACATTACGTTATGACACAGAATTGCTAAC
AGATCATGTAGACCCACAAAAGGGCCGCTTCACTTTGACTTCTCACTCCTTAAAAACGTACCAAGGAGGAG
AAGTTACAGTCCCAGCCAAATGGAAAAGTGACTGTAAGGGTTACCATGGATGTCACAGTTCACAAAAGAG
CTAACAAAACAGATGCCAAATGGTTACTATCTAGAAGGTTTTGTCCGCTTTAGAGATAGTCAAGATGACCA
ACTAAATAGAGTAAACATTCCTTTTGTGGTTTTAAAGGGCAATTTGAAAACCTTAGCAGTTGCAGAAGAGT
CCATTTACAGATTAAAATCTCAAGGCAAAACTGGTTTTTACTTTGATGAATCAGGTCCAAAAGACGATATC
TATGTCGGTAAACACTTTACAGGACTTGTCACTCTTGGTTCAGAGACCAATGTGTCAACCAAACGATTTT
TGACAATGGTCTACACACACTTGGCACCTTTAAAATGCAGATGGCAAATTTATCTTAGAAAAAATGCC
AAGGAAACCCTGTCTTAGCCATTTCTCAAATGGTGACAACAACCAAGATTTTGCAGCCTTCAAAGGTGTT
TTC TTGAGAAAATATCAAGGCTTAAAAGCAAGTGTCTACCATGCTAGTGACAAGGAACACAAAATCCACT
GTGGGTCAGCCAGAAAGCTTTAAAGGAGATAAAAACCTTTAATAGTGACATTAGATTTGCAAAATCAACGA
CCCTGTTAGGCACAGCATTTTCTGGAAAATCGTTAACAGGACTGAATTACAGATGGGCATTATCATTAT
GTGGTGTCTTATTACCCAGATGTGGTCCGGTCCAAAACGTCAAGAAATGACATTTGACATGATTTTAGACCG
ACAAAACCGGTACTATCACAAGCAACATTTGATCCTGAAAACAAACCGATTCAAACCAGAACCCTTAAAAG
ACCGTGGATTAGCTGGTGTTCGCAAAGACAGTGTCTTTTATCTAGAAAAGAAAAGACAACAAGCCTTATACA
GTTACGATAAACGATAGCTACAAATATGTCTCAGTAGAAGACAATAAAACATTTGTGGAGCGACAAGCTGA
TGGCAGCTTTATCTTGCCGCTTGATAAAGCAAAATAGGGGATTTCTATTACATGGTTCGAGGATTTTGCAG
GGAACGTGGCCATCGCTAAGTTAGGAGATCACTTACCACAAAACATTAGGTAAAACACCAATTAAACTTAAG
CTTACAGACGGTAATATCAGACCAAGAAACCGCTTAAAGATAATCTTGAATGACACAGTCTGACACAGG
TCTAGTCAACAATCAAGCCAGCTAGCAGTGGTGCACCGCAATCAGCCGCAAAGCCAGCTAACAAAGATGA
ATCAGGATTTCTTTATCTCACAAACGAAGATGGGAATAAAGACTTTGTGGCCTTTAAAGGCTTAAAAAT
AACGTGTATAATGACTTAACGGTTAACGTATACGCTAAAAGATGACCACCAAACAAACCCCTATCTGGTC

SEQUENCE LISTING

TAGTCAAGCAGGGCGTAGTGTATCCGCTATTGAAAGTACAGCCCTGGTATGGCATAACAGCCCCGAGGAAGCA
AGGTGATGCCAGGTGATTATCAGTATGTTGTGACCTATCGTGACGAACATGGTAAAGAACATCAAAAGCAG
TACACCATATCTGTGAATGACAAAAACCAATGATCACTCAGGGACGTTTTGATACCATTAATGGCGTTGA
CCACTTTACTCCTGACAAGACAAAAGCCCTTGACTCATCAGGCATTGTCCGCGAAGAAGTCTTTTACTTGG
CCAAGAAAAATGGCCGTAATTTGATGTGACAGAAGGTAAGATGGTATCACAGTTAGTGACAATAAGGTG
TATATCCCTAAAAATCCAGATGGTCTTACACCATTTCAAAAAGAGATGGTGTACACTGTCA GATTATTA
CTACCTTGTCGAAGATAGAGCTGGTAATGTGTCTTTTGTCTACCTTGCCTGACCTAAAAGCGGT CGGAAAAG
ACAAAGCAGTAGTCAATTTTGGATTAGACTTACCGGTCCCTGAAGACAAAACAAATAGTGAAC TTTACCTAC
CTTGTGCGGGATGCAGATGGTAAACCGATTGAAAACCTAGAGTATTATAATAACTCAGGTAACAGTCTTAT
CTTGCCATACGGCAAATACACGGTCGAATTGTTGACCTATGACACCAATGCAGCCAAACTAGAGTCAGATA
AAATCGTTTTCTTTACCTTTGTCAGCTGATAACAACCTCCAACAAGTTACCTTTAAGATAACGA TGTTAGCA
ACTTCTCAAATAACTGCCACTTTGATCATCTTTTGCCAGAAGGCAGTCGCGTTAGCCTTAAAACAGCTCA
AGATCAGCTAATCCCCTTGAACAGTCTTTGTATGTGCCTAAAGCTTATGGCAAAAACCGTTCAAGAAGGCA
CTTACGAAGTTGTTGTCAGCCTGCCTAAAGGCTACCGTATCGAAGGCAACACAAAGGTGAATA CCTACCA
AATGAAGTGCACGAAC TATCATTACGCCTTGTCAAAGTAGGAGATGCCTCAGATTCAACTGGTGATCATAA
GGTTATGTCAAAAAATAATTCACAGGCTTTGACAGCCTCTGCCACACCAACCAAGTCAACGACCTCAGCAA
CAGCAAAAGCCCTACCATCAACGGGTGAAAAAATGGGTCTCAAGTTGCGCATAGTAGGCTTGTTGTTACTC
GGACTTACTTGCCTCTTAGCCGAAAAAATCAACCAAAGATTGA

SEQ ID NO: 118 amino acid sequence comprising N-terminal leader sequence of GAS 7
MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVA

SEQ ID NO: 119 amino acid sequence comprising a fragment of GAS 7 where the N-terminal
leader sequence is removed

ADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQDTSQITLKTNREKEQSQDLVSEPTTTELADTDAAS
MANTGSDATQKSASLPPVNTDVHDVWVKTGAWDKGYKQGKVVAVIDTGDIDPAHQSMRISDVSTAKVKSKE
DMLARQKAAGINYSWINDKVVFAHNYVENS DN I KENQFEDFDEDWENFEFDAEAEPKAIKHKIYRQST
QAPKETVIKTEETDGDHIDWTQDDDTKYESHGMHVTGIVAGNSKEAAAATGERFLGIAPEAQVMFMRVFA
NDIMGSAESLFIKAIEDAVALGADV INLSLGTANGAQLSGSKPLMEAIEKAKKAGVSVVVAAGNERVYGS
D HDDPLATNPDYGLVGS PSTGRTP TSAVA INSKVVI QRLMTVKEL ENRADLNHGKAI YSESVDFKDIKDSL
G YDKSHQFAYVKESTDAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLI FNNKPGQSNRSMRLTA
NGMGI P S A F I S H E F G K A M S Q L N G N T G S L E F D S V V S K A P S Q K G N E M N H F S N W G L T S D G Y L K P D I T A P G G D I
Y S T Y N D N H Y G S Q T G T S M A S P Q I A G A S L L V K Q Y L E K T Q P N L P K E K I A D I V K N L L M S N A Q I H V N P E T K T T T S P
R Q Q G A G L L N I D G A V T S G L Y V T G K D N Y G S I S L G N I T D T M T F D V T V H N L S N K D K T L R Y D T E L L T D H V D P Q K G R
F T L T S H S L K T Y Q G G E V T V P A N G K V T V R V T M D V S Q F T K E L T K Q M P N G Y Y L E G F V R F R D S Q D D Q L N R V N I P F V
G F K G Q F E N L V A E E S I Y R L K S Q G K T G F Y F D E S G P K D D I Y V G K H F T G L V T L G S E T N V S T K T I S D N G L H T L G T
F K N A D G K F I L E K N A Q G N P V L A I S P N G D N N Q D F A A F K G V F L R K Y Q G L K A S V Y H A S D K E H K N P L W V S P E S F K G
D K N F N S D I R F A K S T L L G T A F S G K S L T G A E L P D G H Y H V V S Y P D V V G A K R Q E M T F D M I L D R Q K P V L S Q A T
F D P E T N R F K P E P L K D R G L A G V R K D S V F Y L E R K D N K P Y T V T I N D S Y K Y V S V E D N K T F V E R Q A D G S F I L P L D K
A K L G D F Y M V E D F A G N V A I A K L G D H L P Q T L G K T P I K L K L T D G N Y Q T K E T L K D N L E M T Q S D T G L V T N Q A Q L A
V V H R N Q P Q S Q L T K M N Q D F F I S P N E D G N K D F V A F K L K N V Y N D L T V N V Y A K D D H Q K Q T P I W S S Q A G A S V S A
I E S T A W Y G I T A R G S K V M P G D Y Q Y V V T Y R D E H G K E H Q K Q Y T I S V N D K K P M I T Q G R F D T I N G V D H F T P D K T K A
L D S S G I V R E E V F Y L A K K N G R K F D V T E G K D G I T V S D N K V Y I P K N P D G S Y T I S K R D G V T L S D Y Y Y L V E D R A G N
V S F A T L R D L K A V G K D K A V V N F G L D L P V P E D K Q I V N F T Y L V R D A D G K P I E N L E Y Y N N S G N S L I L P Y G K Y T V E
L L Y D T N A A K L E S D K I V S F T L S A D N N F Q Q V T F K I T M L A T S Q I T A H F D H L L P E G S R V S L K T A Q D Q L I P L E Q S
L Y V P K A Y G K T V Q E G T Y E V V V S L P K G Y R I E G N T K V N T L P N E V H E L S L R L V K V G D A S D S T G D H K V M S K N N S Q A
L T A S A T P T K S T T S A T A K A L P S T G E K M G L K L R I V G L V L L G L T C V F S R K K S T K D

SEQ ID NO: 120 amino acid sequence comprising C-terminal hydrophobic region
LPSTGEKMGLKLRIVGLVLLGLTCVFSRKKSTKD

SEQ ID NO: 121 amino acid sequence comprising a fragment of GAS 7 where the C-terminal
hydrophobic region is removed

MEKKQRFSLRKYKSGTFSVLIGSVFLVMTTVADELSTMSEPTITNHAQQQAQHLTNTLSSAESKSQDT
SQITLKTNREKEQSQDLVSEPTTTELADTDAASMANTGSDATQKSASLPPVNTDVHDVWVKTGAWDKGYK
QGKVVAVIDTGDIDPAHQSMRISDVSTAKVKS KEDMLARQKAAGINYSWINDKVVFAHNYVENS DN I KENQ

SEQUENCE LISTING

FEDFDEDWENPEFDAEAEPKAIKKHKIYRQSTQAPKETVIKTEETDGSHDIDWTQTD DDTKYESHGMHVT
GIVAGNSKRAAATGERFLGIAPEAQVMFMRVFA NDIMGSAESLFIKAI EDAVALGADV INLSLGTANGAQL
SGSKPLMEAI EKAKKAGVSVVVAAGNERVYGS DHDDPLATNP DYGLVGS PSTGRTP TSVAAINSKWVIQRL
MTVKEL ENRADLNHGKAIYSESVDFKDIKDSLGYDKSHQFAYVKEST DAGYNAQDVKGKIALIERDPNKTY
DEMIALAKKHGALGVLIFNNKPGQSNRSMRLTANGMGIPSAFISHEFGKAMSQNLNGNGTGSLEFDSVVS KA
PSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDIYSTYNDNHYGSQTGTSMAS PQIAGA SLLVKQYLEKTQP
NLPKEKIADIVKNLLMSNAQIHVNPETKTTTSPRQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNI TD TM
TFDVTVHNLSNKDKTLRYDTELLTDHVDPQKGRFTLTS HSLKTYQGG ETVTPANGKVTVRVTMDVSQFTKE
LTKQMPNGYYLEGFVFRDSDQDDQLNRVNI PFVGFKGQFENLAVAEESIYRLKSQGKTGFYFDES GPKDDI
YVGKHTGLVTLGSETNVSTKTI SDNGLHTLGT FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAFKGV
FLRKYQGLKASVYHASDKEHKNP LWVSPESFKGDKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHY
VVSYPDVVGA KRQEMTFDMI LDRQKPVLSQATFDPETNRFKPEPLKDRGLAGVRKDS VFYLERKDNKPYT
VTINDSYKYVSVEDNKTFVERQADGSFILPLDKAKLGDFFYIMVEDFAGNVAIAKLG D HLPQTLGKTP IKLK
LTDGNYQTKETLKNLEMTQS DTGLVTNQAQLAVVHRNQPSQLTKMNQDFFI SPNEDGNKDFVAFKGLKN
NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSAIESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQ
YTI SVNDKKPMITQGRFDTINGVDHFTPDKTKALDSSGIVREEVFYLA KKNRKFVDVTEGKDGITVSDNKV
YI PKNPDGSYTI SKRDGVTLSDY YLVEDRAGNVSFATLRDLKAVGKDKAVVNFGLDL PVPEDKQIVNFTY
LVRDADGKPIENLEYNNNSGN SLILPYGKYTVELLYDTNAAKLES DKIVSFTLSADNNFQQVTFKITMLA
TSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQSLYVPKAYGKTVQEGTYEVVSLPKGYRIEGNTKVNTLP
NEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQALTASATPTKSTTSATAKA

SEQ ID NO: 122 amino acid sequence comprising a fragment of GAS 57 where both the N-terminal leader sequence and the C-terminal hydrophobic region are removed

ADELSTMSEPTITNHAQQQAHLTNTLSSAESKSQDTSQITLTKTNREKEQSODLVSEPTTTELADTDAAS
MANTGSDATQKSASLPPVNTDVHDWVTKGAWDKGYKGQKVVAVIDTGIDPAHQSMRI SDVSTAKVKSKE
DMLARQKAAGINYG SWINDKVVFAHNYVENS DNIKENQFEDFDEDWENFEFDAEAEPKAIKKHKIYRQST
QAPKETVIKTEETDGS HDIDWTQTD DDTKYESHGMHVTGIVAGNSKRAAATGERFLGIAPEAQVMFMRVFA
NDIMGSAESLFIKAI EDAVALGADV INLSLGTANGAQLSGSKPLMEAI EKAKKAGVSVVVAAGNERVYGS D
HDDPLATNP DYGLVGS PSTGRTP TSVAAINSKWVIQRLMTVKEL ENRADLNHGKAIYSESVDFKDIKDSL G
YDKSHQFAYVKEST DAGYNAQDVKGKIALIERDPNKTYDEMIALAKKHGALGVLIFNNKPGQSNRSMRLTA
NGMGIPSAFISHEFGKAMSQNLNGNGTGSLEFDSVVS KAPSQKGNEMNHFSNWGLTSDGYLKPDI TAPGGDI
YSTYNDNHYGSQTGTSMAS PQIAGASL LVKQYLEKTQPNLPKEKIADIVKNLLMSNAQIHVNPETKTTTSP
RQQGAGLLNIDGAVTSGLYVTGKDN YGSI SLGNI TD TM TFDVTVHNLSNKDKTLRYDTELLTDHVDPQKGR
FTLTS HSLKTYQGG ETVTPANGKVTVRVTMDVSQFTKELTKQMPNGYYLEGFVFRDSDQDDQLNRVNI PFV
GFKGQFENLAVAEESIYRLKSQGKTGFYFDES GPKDDIYVGKHTGLVTLGSETNVSTKTI SDNGLHTLGT
FKNADGKFI LEKNAQGNPVLAI SPNGDNNQDFAAFKGVFLRKYQGLKASVYHASDKEHKNP L WVSPESFKG
DKNFNSDIRFAKSTLLGTAFSGKSLTGAELPDGHYHYVVSYPDVVGA KRQEMTFDMI LDRQKPVLSQAT
FDPETNRFKPEPLKDRGLAGVRKDS VFYLERKDNKPYT VTINDSYKYVSVEDNKTFVER QADGSFILPLDK
AKLGDFFYIMVEDFAGNVAIAKLG D HLPQTLGKTP IKLKLTDGNYQTKETLKNLEMTQS DTGLVTNQAQLA
VVHRNQPSQLTKMNQDFFI SPNEDGNKDFVAFKGLKN NVYNDLTVNVYAKDDHQKQTP IWSSQAGASVSA
IESTAWYGITARGSKVMPGDYQYVV TYRDEHGKEHQKQYTI SVNDKKPMITQGRFDTINGVDHFTPDKTKA
LDSSGIVREEVFYLA KKNRKFVDVTEGKDGITVSDNKVYI PKNPDGSYTI SKRDGVTLSDY YLVEDRAGN
VSFATLRDLKAVGKDKAVVNFGLDL PVPEDKQIVNFTY LVRDADGKPIENLEYNNNSGN SLILPYGKYTVE
LLTYDTNAAKLES DKIVSFTLSADNNFQQVTFKITMLATSQITAHFDHLLPEGSRVSLKTAQDQLI PLEQS
LYVPKAYGKTVQEGTYEVVSLPKGYRIEGNTKVNTLPNEVHEL SLRLVKVG DASDSTGDHKVMSKNNSQA
LTASATPTKSTTSATAKA

SEQ ID NO: 123 amino acid sequence of a GAS M protein

MAKNNTNRHYSRLRKLKTGTASVAVALTVLGAGFANQTEVKANGDGNPREVIEDLAANNPAIQNIRLRYENK
DLKARLENAMEVAGRDFKRAEELEKAKQALE DQRKDLETKLKELQDYDLAKESTSWDRQRLEKELEEKKE
ALELAIDQASRDYHRATALEKELEEKKALELAIDQASQDYNRANVLEKELETITREQEI NRNLLGNAKLE
LDQLSSEKEQLTIEKAKLEEEKQISDASRQSLRRDLASREAKKQVEKDLANLTAELDKVKEKQISDASR
QGLRRDLASREAKKQVEKDLANLTAELDKVKEEKQISDASRQGLRRDLASREAKKQVEKALEEANSKLA
ALEKLNKELEESKKLTEKEKAELOAKLEAEAKALKEQLAKQAEELAKLRAGKASDSQTPDTPKPGNKAVPGK
GQAPQAGTKPNQNKAPMKETKRQLPSTGETANPFFTAALTVMATAGVAAVVKKREEN

SEQUENCE LISTING

SEQ ID NO: 124 amino acid sequence of GAS SfbI

MSFDGFLLHLLTNELKENLLYGRIQKVNQPFERELVLTIRNHRKNYKLLLSAHPVFGRVQITQADFQNPQV
 PNTFTMIMRKYLQGAVIEQLEQIDNDRIIEIKVSNKNEIGDAIQATLIIEIMGKHSNIIIVDRAENKIIIES
 IKHVGFSQNSYRILPGSTYIEPPKTAAVNPFTITDVPLFEILQTQELTVKSLQQHFQGLGRDTAKELAE
 LTTDKLKRFRFFARPTQANLTTASFAPVLPSSDHFETLSDMLDHFYQDKAERDRINQQASDLIHRVQT
 ELDKNRNKLKQEAELLATENAELFRQKGLLTYLSLVPNNQDSVILDNYTTEGKIEIALDKALTPNQNA
 QRYFKKYQKLKEAVKHL SGLIADTKQSITYFESVDYNLSQASIDDIEDIREELYQAGFLKSRQRDKRHKRK
 KPEQYLASDGTIILMVGRRNQLQNEELTFKMAKKGELWFHAKDIPGSHV I IKDNLDPSEVKTDAAELAAYY
 SKARLSNLVQVDMIEAKKLHKPSPGAKPGFVITYTGQKTLRVTPDQAKILSMKLS

SEQ ID NO: 125 amino acid sequence of a GAS Shp protein

MTKVVIKQLLQVIVVFMISLSTMTNLVYADKQIYGCIIQRNHRHPISGQIEDSGGEHSFDIGQGMVEGTV
 YSDAMLEVS DAGKIVLTFRMSLADYSGNYQFWIQPGTGSFQAVDYNITQKGTDTNGTTLIDIAISLPTVNS
 IIRGSMFVEPMGREVVFYLSASELIQKYSGNMLAQLVETDQNSQNEVKDSQKPVDTKLGESQDESHTGAM
 ITQNKPKANSSNNKLSLDDKILPSKMGLTTSLELKKEDKFRSKKDL SIMIYYPPTFFLMLGGFAVWVWKKR
 KKNDKTM

SEQ ID NO: 126 amino acids 10 to 30 of GAS protein SagA

FSIATGSGNSQGGSGSYTPGKC

SEQ ID NO: 127 polynucleotide sequence comprising fusion construct 117-40a-RR

ATGGCCTTTAACAACAAGCCAGAGTGCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
 TGATGAAAATCACACCTGCAATATAGTAAAGACAACGCACAACCTCAATTGAGAAATATCCTTGACGGCT
 ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCA
 AGTGAGCAAGACATTGAAAAACTATGAAGAGCTTAAAGAACAAGTTACATGATATGTACAATCATTATG
 CAGCGGTGGCGGATCCATGAGTGTAGGCGTATCTCACCAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
 CGAAGGCGAGTAATACTCAGCAGATAGTTTACCAAACCAGAAACAATTCAGAGGCAAAGGCAACTATT
 GATGCAGTTGAAAAAAGCTCTCAGTCAACAAAAGCAGAACTGACAGAGCTTGCTACCGCTCTGACAAAAAC
 TACTGTGTAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
 TTTACTACTAATCTTTGCAAGTAGTGAGGAGCGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
 ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAGAGACTGCATTGTCGAGACA
 AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAACAAGTCAAACCGTCTGAACAAA
 ATATTGCTAAGCTCAATGCTATGATTAGCAATCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
 AATACAAAAGCATTAAAGCTCAGAAATGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAA
 AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAGAGGCGAAGCTTAGTCGTC
 TTAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
 CCTCTTGAAGAAGCTTAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
 AGAGCATGCAGATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATCCAG
 CAGATCGTAATCGCTTTGTTGATCCCGATAAATTTGACACCAGAAAGTGCAAAATGAGCTAGCGCAGTTGCA
 GCTCACATGATTAATAGTGTAAGTCAATTTAGGCTTACCACCAGTTACTGTTACAGCAGGATCACAAGA
 ATTTGCAAGATTACTTAGTACCAGCTATAAGAAACTCATGGTAATACAAGACCATCATTGTCTACGGAC
 AGCCAGGGGTATCAGGGCATTATGGTGTGGGCCCTCATGATAAACTATATTGAAGACTCTGCCGGAGCG
 TCAGGGCTCATTGAAATGATGATAACATGTACGAGAATATCGGTGCTTTAACGATGTGCATACTGTGAA
 TGGTATTAACGTTGATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTACACGGAAATACAT
 ACGGCCATGCTATTAACCTTTTACGTGTAGATAAACATAACCCTAATGC GCCTGTTTACCTTGGATTTCA
 ACCAGCAATGTAGGATCTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACATTGCTAACCATCAACG
 CTTTAATAAGACCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCC AAAAGAGTAGGCACCTGTATCTG
 ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCCGCTATTTCATCAAGAAGCT
 GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAAATTAGCAAGCACACTTAAGCAGTCAGA
 CAGCTTAAATCTCCAAGTGAGACAATTAATGATACTAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
 AAGCAAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAAGCTAGCATCGTTGAAAGCCGCA
 CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGAGCCAGAGTGACAGCACCTGGTGGCTAAAAAAGCTCA
 TTTGCAATATCTAAGGGACTTTAAATGAAATCCTAACCGCCTTCAAGTGATACGTGAGCGCATTGATAATA
 CTAAGCAAGATTTGGCTAAAACCTACCTCATCTTTGTTAAATGCACAAGAAGCTTTAGCAGCCTTACAAGCT
 AAACAAAGCAGCTAGAAGCTACTATTGCTACCAGAAACACCAGTTGACTTTGCTTAAAACCTTAGCTAA
 CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA

SEQUENCE LISTING

CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTC AAGAAATGGTTAAAGAAACG
AAACAAC TATTAGAAGCTTCAGCAAGATTAGCTGCTGAA AATACAAGTCTTGTAGCAGAAGCGCTTGTGG
CAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGCTAAAATCACATCTTCGATTACTCAGCCCTCAT
CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTCTGATGTTGATGAAAGTACTCAA
cGtgcgggccgactcgagCACCACCACCACCACCAC

SEQ ID NO: 128 amino acid sequence comprising fusion construct 117-40a-RR

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q F A A H M I N S
V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
S F V Y G Q P G V G S G H Y G V G P H D K T I I E D S A G A S G L I R N D
D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V
S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
N T K Q D L A K T T S L L N A Q E A L A A L Q A K Q S S L E A T I A T
T E H Q L T L K T S L A N E K E Y R H L D E D I A T V P D L Q V A P P L
T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 129 amino acid sequence comprising a linker in the 117-40a-RR construct
YASGGGS

SEQ ID NO: 130 polynucleotide sequence comprising 40a-RR-117 fusion construct

ATGAGTGTAGGCGTATCTCACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAACGAAGGCGAGTAATAC
TCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCAAAGGCAACTATTGATGCAGTTGAAAAA
CTCTCAGTCAACAAAAGCAGAAGTACAGAGCTTGCTACCGCTCTGACAAAACTACTGCTGAAATCAAC
CACTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACTCTGCACAAGAAATTTACACTAATACTCT
TGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTAACAGCTACTGAAACAG
AGCTTCATAATGCTCAAGCAGATCAACATTCAAAAAGAGACTGCATTGTCAGAACAAAAAGCTAGCATTTC
GCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACGCTCTGAACAAAATATTGCTAAGCTCAA
TGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGATAATACAAAGCATTAA
GCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAAAAGCAATTGACTGAA
GAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGCTTAAATCCTCAGCTCC
GTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAAGCACCAGGCTATCCTCTTGAAGAACTTA
AAAAATTAGAAGCTAGTGGTTATATTGGATCAGTAGTTACAATAATTATTACAAAGAGCATGCAGATCAA
ATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAGCAGATCGTAATCGTCT
TGTGTGATCCCATAATTTGACACCAGAAGTGCAAAATGAGCTAGCGCAGTTTGCAGCTCACATGATTAATA
GTGTAcGtCgtCAATTAGGTCTACCACCAGTACTGTTACAGCAGGATCACAGAATTTGCAAGATTACTT
AGTACCAGCTATAAGAAAACCTCATGGTAATACAAGACCATCATTTGTCTACGGACAGCCAGGGGTATCAGG
GCATTATGGTGTGGCCCTCATGATAAACTATTATTGAA GACTCTGCCGGAGCGTCAGGGCTCATTGCAA
ATGATGATAACATGTACGAGAATATCGGTGCTTTTAAACGATGTGCATACTGTGAATGGTATTAAACGTGGT

SEQUENCE LISTING

ATTTATGACAGTATCAAGTATATGCTCTTTACA GATCATTTACACGGAAATACATACGGCCATGCTATTAA
CTTTTTACGTGTAGATAAACATAACCCTAATGC GCCTGTTTACCTTGGATTTTCAACCAGCAATGTAGGAT
CTTTGAATGAACACTTTGTAATGTTTCCAGAGTCTAACAGATGCTAACCATCAACGCTTTAATAAGACCCCT
ATAAAGCCGTTGGAAGTACAAAAGATTATGCC CAAAGAGTAGGCACCTGTATCTGATACTATTGCAGCGAT
CAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTCTGGCTATTCATCAAGAAGCTGATATTATGGCAGCCC
AAGCTAAAGTAAGTCAACTTCAAGGTAAATTAG CAAGCACACTTAAGCAGTCAGACAGCTTAAATCTCCAA
GTGAGACAATTAATGATACTAAAGGTTCTTTG AGAACAGAATTACTAGCAGCTAAAGCAAAAACAAGCACA
ACTCGAAGCTACTCGTGATCAATCATTAGCTAA GCTAGCATCGTTGAAAGCCGCACTGCACCAGACAGAAG
CCTTAGCAGAGCAAGCCGAGCCAGAGTGACAG CACTGGTGGCTAAAAAGCTCATTTGCAATATCTAAGG
GACTTTAAATTGAATCCTAACCGCCTTCAAGTG ATACGTGAGCGCATTGATAATACTAAGCAAGATTTGTC
TAAACTACCTCATCTTTGTTAAATGCACAAGA AGCTTTAGCAGCCTTACAAGCTAAACAAAGCAGTCTAG
AAGCTACTATTGCTACCACAGAACACCAGTTGA CTTTGCTTAAACCTTAGCTAACGAAAAGGAATATCGC
CACTTAGACGAAGATATAGTACTGTCCTGATTTGCAAGTAGCTCCACCTCTTACGGGCGTAAACCAGCT
ATCATATAGTAAGATAGATACTACTCCGCTTGT TCAAGAAATGGTTAAAGAAAACGAAAACAATATAGAAG
CTTCAGCAAGATTAGCTGCTGAAAATACAAGTC TTGTAGCAGAAGCGCTTGTGGCCAAAACCTCTGAAATG
GTAGCAAGTAATGCCATTGTGTCTAAAATCACA TCTTCGATTACTCAGCCCTCATCTAAGACATCTTATGG
CTCAGGATCTTCTACAACGAGCAATCTCATTTC TGATGTTGATGAAAGTACTCAACGGCTAGCGGTTGGG
gatccatggcctttaacacaagccagagtgctcagtgccacaagtttatagcaatgaaggggtatcaccagcat
TTGACTGATGAAAAATCACACCTGCAATATAGT AAAGACAACGCACAACCTTCAATTGAGAAAATATCCTTGA
CGGCTACCAAAATGACCTAGGGAGACACTACTC TAGCTATTATTACTACAACCTAAGAACCCTTATGGGAC
TATCAAGTGAGCAAGACATTGAAAACACTATGA AAGAGCTTAAAGAACAAGTTACATGATATGTACAATCAT
TATgcgccgcactcgagcaccaccaccaccacc

SEQ ID NO: 131 amino acid sequence comprising the 40a-RR-117 fusion construct

M S V G V S H Q V K A D D R A S G E T K A S N T H D D S L P K P E T I Q
E A K A T I D A V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H
L K E Q Q D N E Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E
H Q R E L T A T E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E
T T R A Q D L V E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q
T A N D N T K A L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A
A Q K A A L A E K E A E L S R L K S S A P S T Q D S I V G N N T M K A P
Q G Y P L E E L K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K
A S P G N Q L N Q Y Q D I P A D R N R F V D P D N L T P E V Q N E L A Q
F A A H M I N S V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K
K T H G N T R P S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G
A S G L I R N D D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K
Y M L F T D H L H G N T Y G H A I N F L R N V D K H N P N A P V Y L G F S
T S N V G S L N E H F V M F P E S N I A N H Q R F N K T P I K A V G S T
K D Y A Q R V G T V S D T I A A I K G K V S S L E N R L S A I H Q E A D
I M A A Q A K V S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K
G S L R T E L L A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H
Q T E A L A E Q A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L
Q V I R E R I D N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S
S L E A T I A T T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P
D L Q V A P P L T G V K P L S Y S K I D Q T P L V Q E M V K E T K Q L T
E A S A R L A A E N T S L V A E A L V G Q T S E M V A S N A I V S K I T
S S I T Q P S S K T S Y G S G S S T S N L I S D V D E S T Q R A S G G
G S M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K
D N A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L
S S E Q D I E K H Y E E L K N K L H D M Y N H Y A A A L E H H H H H

SEQ ID NO: 132 polynucleotide sequence comprising fusion construct GAS 117 - 40a

ATGGCCTTTACACAAGCCAGAGTGTCTAGTGCAC AAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
TGATGAAAAATCACACCTGCAATATAGTAAAGAC AACGCACAACCTTCAATTGAGAAATATCCTTGACGGCT
ACCAAAATGACCTAGGGAGACACTACTCTAGCTA TTATTACTACAACCTAAGAAC GTTATGGGACTATCA
AGTGAGCAAGACATTGAAAACACTATGAAGAGC TTAAGAACAAGTTACATGATATGTACAATCATTATgc

SEQUENCE LISTING

ATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACAGAAACAATTCAAGAGGCAAAGGCAACTATT
GATGCAGTTGAAAAAAGCTTCAGTCAACAAAAGCAGAAGTGCAGAGCTTGCTACCGCTCGACAAAAAC
TACTGCTGAAATCAACCACATAAAAGAGCAGCAAGATAATGAACAAAAGCTTTAACCTCTGCACAAGAAA
TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTCAAAAGAGACTGCATTGTGCAACA
AAAAGCTAGCATTTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGAACAAGTCAAACGCTGTAACAAA
ATATTGCTAAGCTCAATGCTATGATTAGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
AATACAAAAGCATTAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAATCAAAGCTAAAGTTAA
AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAAGCTTAGTCGTC
TTAAATCCTCAGCTCCGCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
CCTCTTGAAGAAGCTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
AGAGCATGCAGATCAAATTTATGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGATATTCCAG
CAGATCGTAATCGCTTTGTTGATCCCAGATAATTTGACACCAGAAGTGCAAAATGCTAGCGCAGTTTGCA
GCTCACATGATTAATAGTGTAAAGAAGACAATTAGGTCTACCACCAGTTACTGTTACAGCAGGATCACAAGA
ATTTGCAAGATTACTTAGTACAGCTATAAGAAAACTCATGGTAATACAAGACCATCATTGTGCTACGGAC
AGCCAGGGGTATCAGGGCATTATGGTGTGGGCCATGATAAAACTATTATTGAAGACTCTGCCGGAGCG
TCAGGGCTCATTGCAAAATGATGATAACATGTACGAGAATATCGGTGCTTTTAACGATGTGCATACGTGAA
TGGTATTAACCGTGGTATTTATGACAGTATCAAGTATATGCTCTTTACAGATCATTTACACGGAAATACAT
ACGGCCATGCTATTAACTTTTACGTGTAGATAAACATAACCCATAATGCGCCTGTTTACCTTGGATTTC
AGCCCAATGTAGGATCTTTGAATGAACACTTTGTAAATGTTTCCAGAGTCTAACATGCTAACCATCAACG
CTTTAATAAGACCCCTATAAAAGCCGTTGGAAGTACAAAAGATTATGCCCAAAGAGTAGGCACGTGATCTG
ATACTATTGCAGCGATCAAAGGAAAAGTAAGCTCATTAGAAAATCGTTTGTGCGCTATTCATCAAGAAGCT
GATATTATGGCAGCCCAAGCTAAAGTAAGTCAACTTCAAGGTAATTAGCAAGCACACTTAAGCAGTCAGA
CAGCTTAAATCTCAAGTGAGACAATPAATGATACATAAAGGTTCTTTGAGAACAGAATTACTAGCAGCTA
AAGCAAAAACAAGCACAACCTCGAAGCTACTCGTGATCAATCATTAGCTAAGCTAGCATCGTTGAAAGCCGCA
CTGCACCAGACAGAAGCCTTAGCAGAGCAAGCCGACAGCAGAGTGACAGCACTGGTGGCTAAAAAGCTCA
TTTGCAATATCTAAGGGACTTTAAATGAAATCCTAACCGCTTCAAGTGATACGTGAGCGCATTTGATAATA
TTAAGCAAGATTGGCTAAAACCTACCTCATCTTTGTTAAATGCAACAAGAAGCTTTAGCAGCCTTACAAGCT
AAACAAAAGCAGTCTAGAAGCTACTATTGCTACCACAGAACCAGTTGACTTTGCTTAAAACCTTAGCTAA
CGAAAAGGAATATCGCCACTTAGACGAAGATATAGCTACTGTGCCTGATTTGCAAGTAGCTCCACCTCTTA
CGGGCGTAAAACCGCTATCATATAGTAAGATAGATACTACTCCGCTTGTTCAGAAATGGTTAAAGAAACG
AAACAACCTATTAGAAGCTTCAGCAAGATTAGCTGCTGAAAATACAAGTCTTGTAGCAGAAGCGCTTGTGG
CCAAACCTCTGAAATGGTAGCAAGTAATGCCATTGTGCTAAAATCACATCTTCGATTACTCAGCCCTCAT
CTAAGACATCTTATGGCTCAGGATCTTCTACAACGAGCAATCTCATTTCTGATGTTGATGAAAGTACTCAA
cGtgcgggccgcactcgagCACCACCACCACCAC

SEQ ID NO: 133 amino acid sequence comprising fusion construct GAS 117-40a

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
E Q V K T S E Q N I A K L N E M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K K Q L T E E L A A Q A K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q D I P A D R N R F V D P D N L T P E V Q N G L A Q F A A H M I N S
V R R Q L G L P P V T V T A G S Q E F A R L L S T S Y K K T H G N T R P
S F V Y G Q P G V S G H Y G V G P H D K T I I E D S A G A S G L I R N D
D N M Y E N I G A F N D V H T V N G I K R G I Y D S I K Y M L F T D H L
H G N T Y G H A I N F L R V D K H N P N A P V Y L G F S T S N V G S L N
E H F V M F P E S N I A N H Q R F N K T P I K A V G S T K D Y A Q R V G
T V S D T I A A I K G K V S S L E N R L S A I H Q E A D I M A A Q A K V

SEQUENCE LISTING

S Q L Q G K L A S T L K Q S D S L N L Q V R Q L N D T K G S L R T E L L
A A K A K Q A Q L E A T R D Q S L A K L A S L K A A L H Q T E A L A E Q
A A A R V T A L V A K K A H L Q Y L R D F K L N P N R L Q V I R E R I D
N T K Q D L A K T T S S L L N A Q E A L A A L Q A K Q S S L E A T I A T
T E H Q L T L L K T L A N E K E Y R H L D E D I A T V P D L Q V A P P L
T G V K P L S Y S K I D T T P L V Q E M V K E T K Q L L E A S A R L A A
E N T S L V A E A L V G Q T S E M V A S N A I V S K I T S S I T Q P S S
K T S Y G S G S S T T S N L I S D V D E S T Q R A A A L E H H H H H

SEQ ID NO: 134 polynucleotide sequence comprising fusion construct GAS 117-40N

ATGGCCTTTAACACAAGCCAGAGTGTCAAGTTCAGTGCACAAGTTTATAGCAATGAAGGGTATCACCAGCATTGAC
TGATGAAAAATCACACCTGCAATATAGTAAAGACAACGCCACAACCTCAATTGAGAAATATCCTTGACGGCT
ACCAAAATGACCTAGGGAGACACTACTCTAGCTATTATTACTACAACCTAAGAACCCTTATGGGACTATCA
AGTGAGCAAGACATGAAAAACACTATGAAGAGCTTAAGAACAAGTTACATGATATGTACAATCATTATG
tagcggtagcggatccCATGAGTGTAGGCGTATCTACCAAGTCAAAGCAGATGATAGAGCCTCAGGAGAAA
CGAAGGCGAGTAATACTCACGACGATAGTTTACCAAACCAGAAACAATTCAAGAGGCCAAAGGCAACTATT
GATGCAGTTGAAAAACTCTCAGTCAACAAAAGCAGAAGTGCAGAGCTTGCTACCGCTCTGACAAAAAC
TACTGCTGAAATCAACCCTTAAAAGAGCAGCAAGATAATGAACAAAAAGCTTTAACCTCTGCACAAGAAA
TTTACACTAATACTCTTGCAAGTAGTGAGGAGACGCTATTAGCCCAAGGAGCCGAACATCAAAGAGAGTTA
ACAGCTACTGAAACAGAGCTTCATAATGCTCAAGCAGATCAACATTTCAAAGAGACTGCATTTGTCAGAACA
AAAAGCTAGCATTTCAGCAGAACTACTCGAGCTCAAGATTTAGTGGAAACAAGTCAAACCGTGAACAAA
ATATTGCTAAGCTCAATGCTATGATGATGCAATCCTGATGCTATCACTAAAGCAGCTCAAACGGCTAATGAT
AATACAAAAGCATTAAAGCTCAGAATTGGAGAAGGCTAAAGCTGACTTAGAAAAATCAAAGCTAAAGTTAA
AAAGCAATTGACTGAAGAGTTGGCAGCTCAGAAAGCTGCTCTAGCAGAAAAAGAGGCAGAACTTAGTCGTC
TAAATCCTCAGTCCGTCTACTCAAGATAGCATTGTGGGTAATAATACCATGAAAGCACCGCAAGGCTAT
CCTCTTGAGAACTTAAAAAATTAGAAGCTAGTGGTTATATTGGATCAGCTAGTTACAATAATTATTACAA
AGAGCATGCAGATCAAATTATTGCCAAAGCTAGTCCAGGTAATCAATTAATCAATACCAAGcggccgcac
tcgagCACCACCACCACCACCAC

SEQ ID NO: 135

M A F N T S Q S V S A Q V Y S N E G Y H Q H L T D E K S H L Q Y S K D N
A Q L Q L R N I L D G Y Q N D L G R H Y S S Y Y Y Y N L R T V M G L S S
E Q D I E K H Y E E L K N K L H D M Y N H Y A S G G G S M S V G V S H Q
V K A D D R A S G E T K A S N T H D D S L P K P E T I Q E A K A T I D A
V E K T L S Q Q K A E L T E L A T A L T K T T A E I N H L K E Q Q D N E
Q K A L T S A Q E I Y T N T L A S S E E T L L A Q G A E H Q R E L T A T
E T E L H N A Q A D Q H S K E T A L S E Q K A S I S A E T T R A Q D L V
E Q V K T S E Q N I A K L N A M I S N P D A I T K A A Q T A N D N T K A
L S S E L E K A K A D L E N Q K A K V K Q L T E E L A A Q K A A L A E
K E A E L S R L K S S A P S T Q D S I V G N N T M K A P Q G Y P L E E L
K K L E A S G Y I G S A S Y N N Y Y K E H A D Q I I A K A S P G N Q L N
Q Y Q A A A L E H H H H H H

SEQ ID NO: 136

AGTTGGTA

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